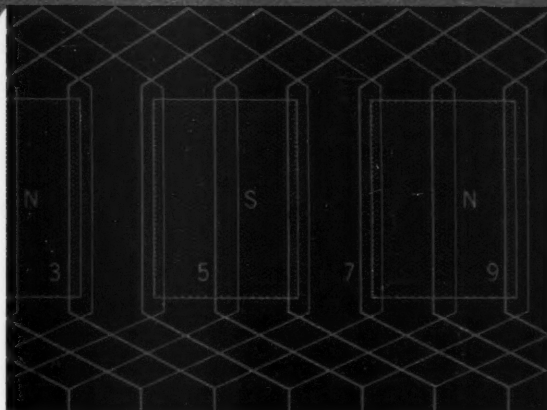


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Design Engineering

JANUARY 1960

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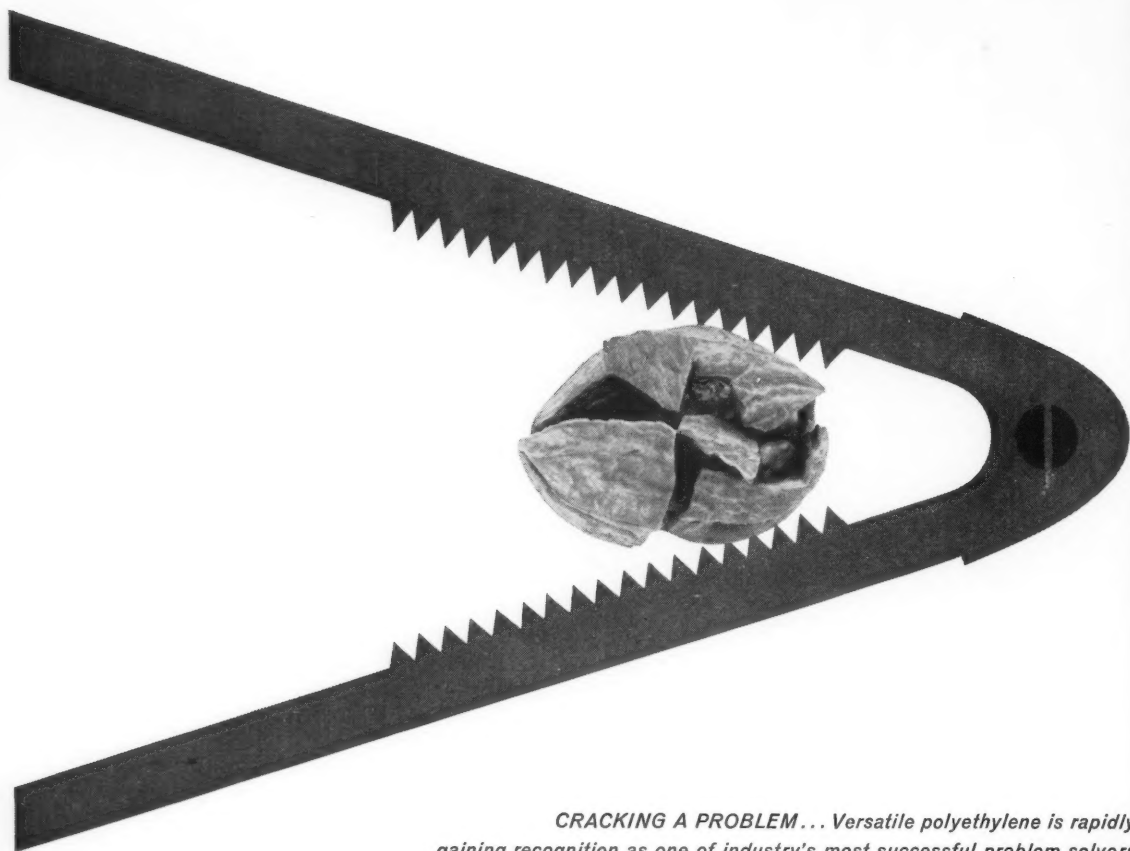


Motor selection . . . p 31

Induction motors . . . p 38

Motor insulation . . . p 41

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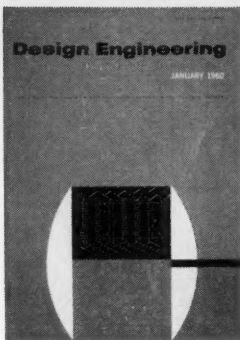
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Design Engineering

Vol. 6

JANUARY 1960

No. 1

This month's cover

This issue scrutinizes the standards, sizes, insulation and application of electric motors — and the cover sums it up. The technique used by artist Bryan Mills is interpretive rather than stylized, and introduces a new look into DE covers. Our photograph on page 41 exposes the secrets of insulation and Mills has uncovered some vital points too, as you can see.

★ ★ ★

Design Engineering

MEMBER

CCAB

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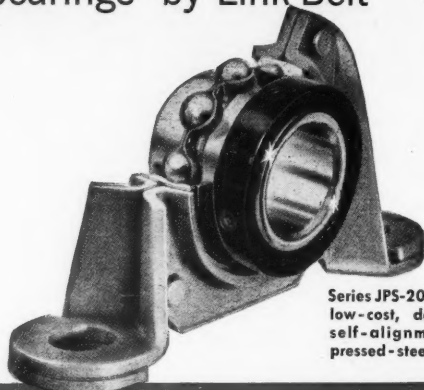
Industry's most complete line . . .

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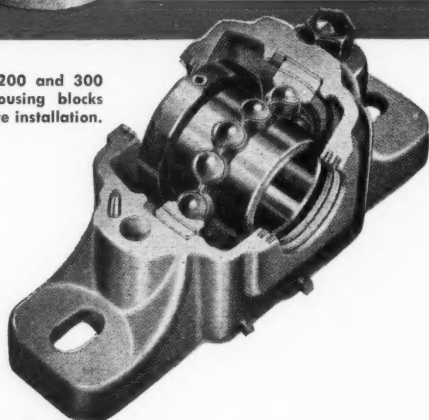


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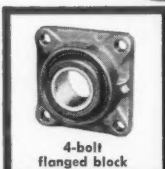
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Another busy engineer unearthed

Next step in **Bruce Newman's** career we believe, is to get his M.A.Sc. Author of "Match the motor to the job", he is an electrical engineering graduate of U of Toronto, class of 1942. In addition to his responsibilities with Wagner Electric, Newman has to contend with three daughters — has taken a major part in the organizing of four suburban churches.

No change on the Eggleton front

Last time **L. S. (Larry) Eggleton** wrote for us was in the May 1959 issue. His current piece "Seaway is test for underwater actuator" stems from his work at Aviation Electric in Montreal where he is in charge of technical publications.

Man from prairies no water-baby

A native Winnipegger now living in Toronto, **E. T. Burch** has done much research into the field of transportation relating to engineering design. His article "Design is always changing" kicks off a new DE series on original designs by Canadian design engineers. Burch is now in promotion work and confesses to living in an apartment house with swimming pool he hasn't used.

Time to give

According to **J. R. M. Szogyen's** background, he's not afraid of giving his time to professional organizations. He's a member of the A.I.E.E., C.E.M.A., International Electrotechnical Commission,

chairman of a C.S.A. committee, is a P.Eng. and also belongs to the E.I.C. As a prelude to this, he studied mechanical engineering in Zurich — took his B.A.Sc. in 1951 at the U. of B.C. Szogyen now works for English Electric in St. Catharines, Ont.

New faces in the Bureaus

Editor of the newly created Ottawa Bureau to serve Maclean-Hunter business publications is **Don Peacock**. Parliamentary press gallery representative for Canadian Press since 1954, Peacock's appointment means greater coverage of events at the nation's capital for DE readers. **Gordon Duffy** is DE's new Montreal editor. An experienced reporter (Halifax Chronicle-Herald, Halifax Mail-Star), he was also Nova Scotia correspondent for Time Inc. Duffy was lately assistant manager of editorial services at M-H. His move to Montreal involves wife, three children — and hefty photographic, hunting and camping equipment.

Insulation man — but not insular

The article on motor insulation is written by **Raymond Bishop**. A CGE man, he took this company's well known Test Course in 1946 after a four year stint with the Canadian Army. He then went on to induction motor design work but since 1951, insulation systems for motors in the 1-2500 hp range has been his chief interest. Bishop has been busy after working hours too — he designed and built his own house.

Newman



Szogyen



Peacock



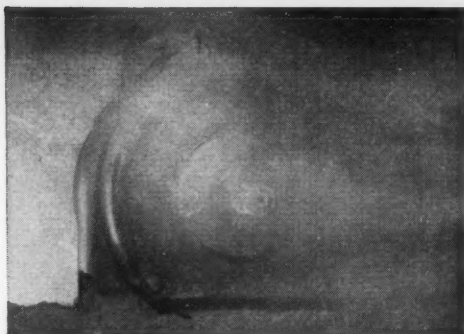
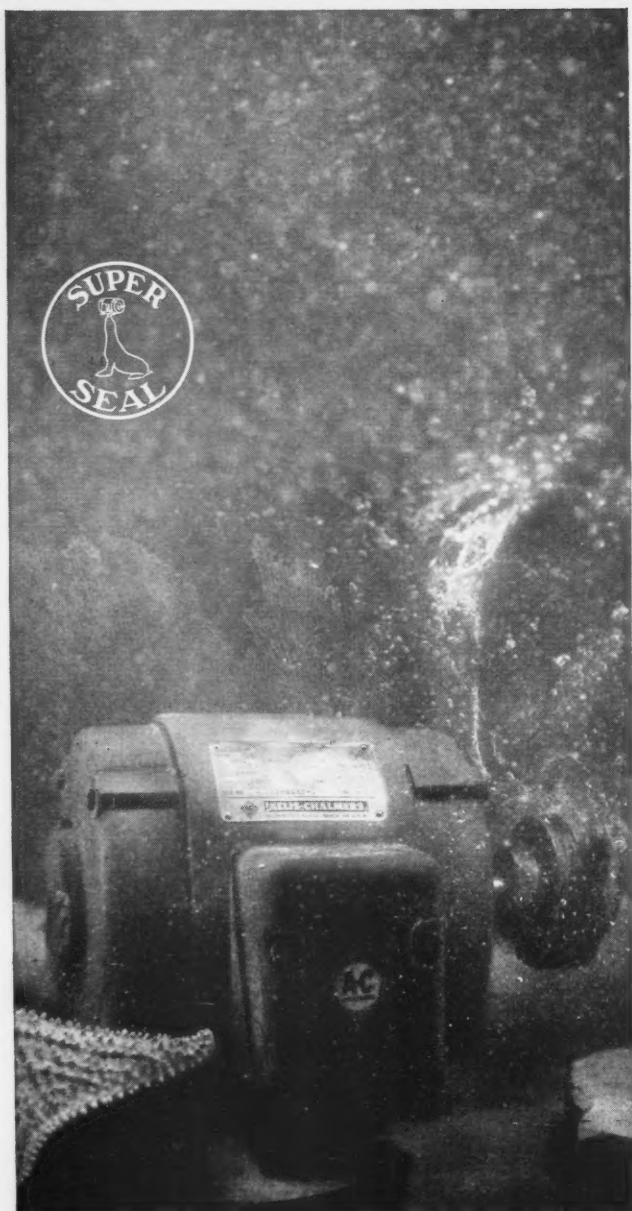
Duffy



Bishop



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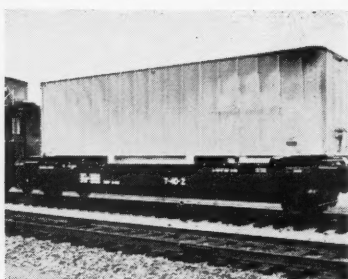
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DESIGN ENGINEERING JANUARY 1960

Reports

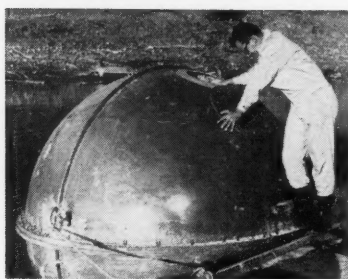
A news roundup of items of engineering and design interest from the world over

Canadian freight-car for piggyback operations



We hear that a firm in Western Ontario is taking a long, hard look at freight-car design for railroad piggyback operations. Our illustration shows a prototype car leaving the London plant of General Motors Diesel Limited. The distinguishing features of the car: it has four wheels only—can be loaded from either side. Canadian Pacific Railway technicians co-operated in the new design. E. V. Rippingille Jr., President of G. M. Diesel, says: "Dieselization of Canadian railroads will continue to make tremendous contributions to low-cost transportation. More in fact than can be expected from the St. Lawrence Seaway. Since piggybacking . . . is the fastest-growing source of railway-car loading . . . it is logical that we do our utmost to advance the art in Canada." Not only a firm opinion, but lexicographers, we suspect, get a new word.

Fibreglass sphere carries wood chips down Fraser River



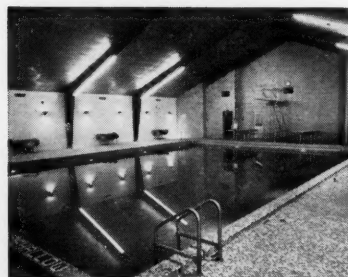
The best and cheapest way of getting wood chips from B. C. interior sawmills down to tidewater might be fibreglass spheres, according to Arthur Joy, DE's west coast editor. Joy has been reporting on the Crown Zellerbach Co.'s experiments. "The eight-foot sphere is a prototype and was selected because it can be handled in shallow waters by one or two men," he reports. "Bolts on the sphere will likely be replaced by a quick-release U-channel and the actual filling done by some sort of blowing device. The sphere is made of one-eighth in. fibreglass, painted red for easy identification. It is made in quarters, two being joined to form fixed halves. These can be nested for easy shipping." Joy says Plasti-Glass Developments worked on the project and more experiments (with other materials) are planned.

All-plastic workboat for tidewater oil fields



Here is the first plastic Jo-Boat ever built. This type of craft is mainly used on the Louisiana and Mississippi Gulf shoreline. It's a flat-bottomed, blunt-nosed workboat with fore and aft access to the cabin. Among other uses it is widely employed by men called "gaugers" and "pumpers" working in the tidewater producing oil fields in the Gulf of Mexico. The 30-ft lapstreak-bottomed craft seats 11 and is molded of fibre-glass-reinforced polyester (and fire-retardant) resin. Hull is in one piece with unified skeg and strut, for the deck, cabin, cabin top, seats, vents, hatches and stringers. All parts use the hand-layup process with special molds required for each part. The fibreglass reinforcement is light cloth, roving and mat. As you can imagine, with these specifications there's a minimum of upkeep required.

Multi-purpose pool for swimming and saving



This isn't a film star's mudhole, but the employees' swimming pool of a company in Bensenville, Ill. Right after work, the staff can take a cool dip or go home for supper and return with the whole family for a swim—and all at no cost. Sounds wonderful for the employees but it's just as good for management too. In fact, by building the pool they saved \$150,000. Instead of buying water from Bensenville for its new plant, the company chose to excavate lagoons on the plant property and draw water from them. Lagoons are kept full by rain drainage from the large roof and parking areas. These, together with the pool, have solved the plant's water supply problem. Flick-Reedy are also using the pool to research chemical and water filters they are developing.

Helicopter carries prefab medical wards



It's all right—we shuddered too when we saw it. The mantis-like object is a development of the Westland "Westminster." Designed to carry pre-fabricated medical wards for use as field hospitals, the unit can carry five tons for 100 miles at 115 mph. Two Napier Eland turboshaft engines provide the power to get the 70 ft. fuselage airborne. Stressing design flexibility, the helicopter can be used as a flying crane, a transport or supply plane. The product of Westland Aircraft Ltd. is the biggest helicopter project ever undertaken as a private venture in the U. K. But we think it will scare the daylight out of some unsuspecting little Piper Cub one of these days.

Canadian radio engineers take course on Elmux



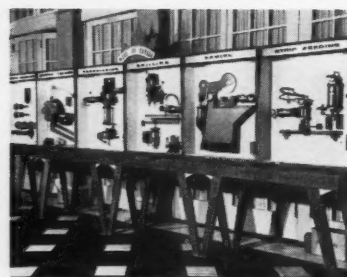
Not long ago, 14 Department of Transport radio engineers and technicians from radio stations across Canada completed the first formal course on Elmux at Carleton University, Ottawa. This is the new Siemens and Halske transistorized error correction equipment for radio time communications. The course was sponsored by the Department of Transport and arranged by the Ahearn and Soper Co. We understand that the Department of Transport is the first organization in the world to use the new electronic, automatic error correction technique on long-wave radio circuits. Elmux recognizes errors as they occur at the receiving station and refuses to print them. As a result, errors are eliminated in received copy when under most adverse conditions.

New design principle in tv antenna



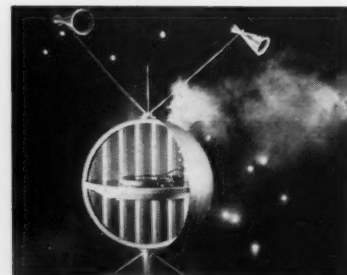
Good-bye rabbit ears? We won't predict that, but this six-inch tv antenna is made to replace them. The unit slides over the tv set's power cord and works on an entirely new reception principle. Though attached to the electrical cord, it uses no power—is said to bring in consistently sharp pictures. The compact device turns the electric wiring in the home into a big tv antenna. It draws tv signals from the cord into the receiver by means of an inductive coupling technique. A tuning-aid permits permanent tuning for best reception on the set, and once attached (at the back out of sight) it moves with the set to any location. Busy engineers will be glad to hear that installation time is a mere 30 seconds.

"Made in Canada" keynote impresses U. S. engineers

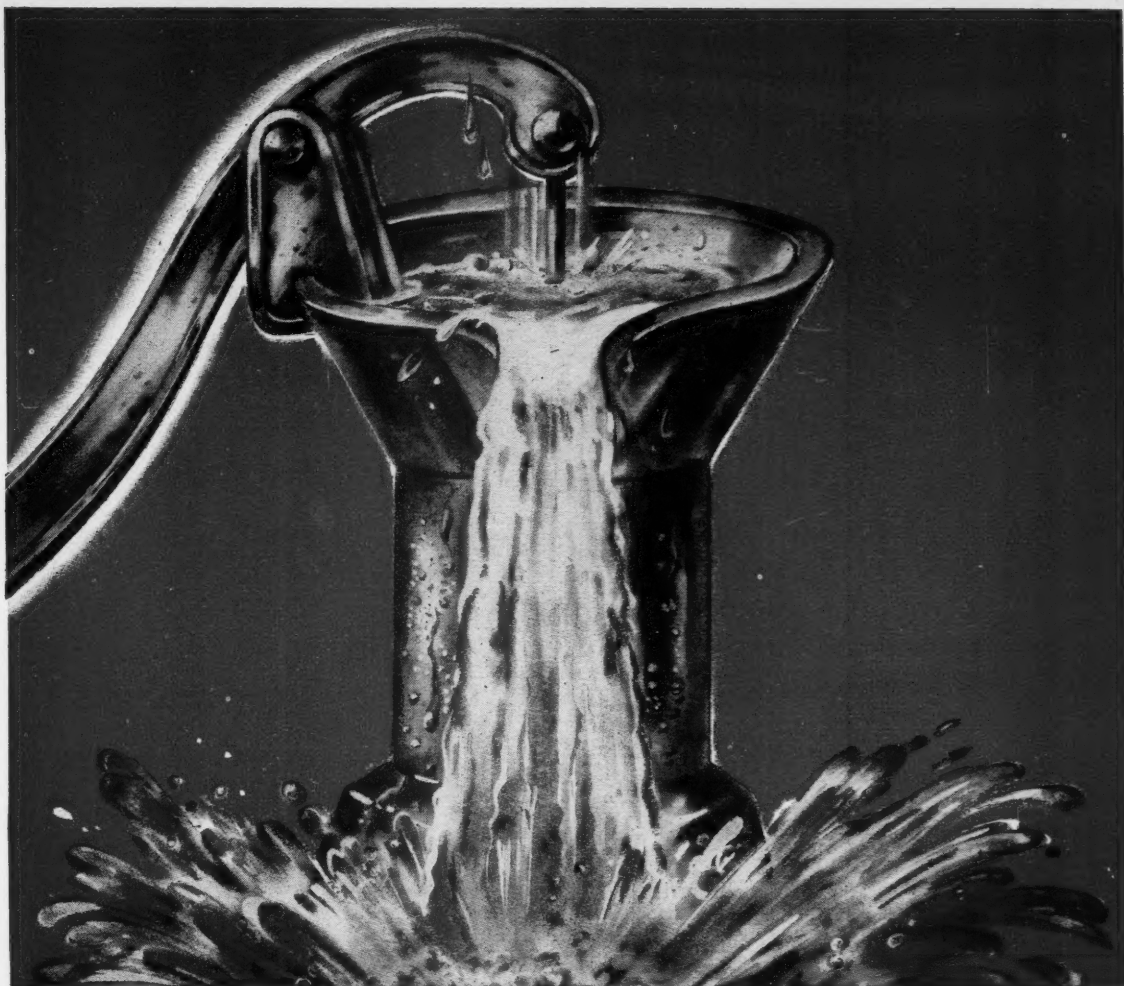


We heard of a Canadian firm bending over backwards to cooperate with a professional engineering society in the U. S. It seems the Olean, N. Y. chapter of A.S.T.E. contacted Bellows-Valvair in Buffalo for an animated pneumatic exhibit for their next meeting. This firm phoned its Toronto office and asked them for help. Don Guy, the Toronto manager told us: "We often get calls like this for the display. In fact it's been shown in dozens of cities from Quebec to Vancouver. Anyway, we started the gears grinding with Customs to get a bond posted—but it came through fairly quickly. Next thing I was loading the cases in my station-wagon and heading south. The Olean chapter was most impressed with the way we played up the 'Made in Canada' publicity. Altogether it was a very rewarding experience."

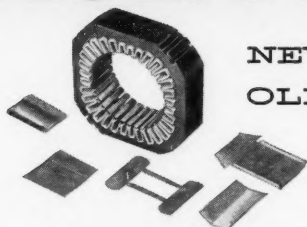
The music does go around and around . . .



We should warn you that this is not something from outer space, but a Music Sphere. Briefly, it's termed a "wholly new approach to the design of stereophonic hi-fidelity system enclosures." Creator: Lester Beall for Alcoa. Beall sought the visual grace of a musical instrument in his design; appears to have got it. Extending satellite speakers telescope into the main body when the system is not in use. When open, it reveals brilliant vertical bands of color. The Music Sphere is a 3-ft aluminum globe, mounted on a tubular shaft rising from a four-legged stand. The front is a hemisphere which rotates around the vertical shaft, telescoping around rear portion to expose turntable and amplifier controls. Sorry, hi-fi-ends, but the item is not a production model.



MOISTURE RESISTANCE



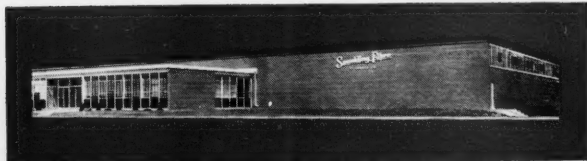
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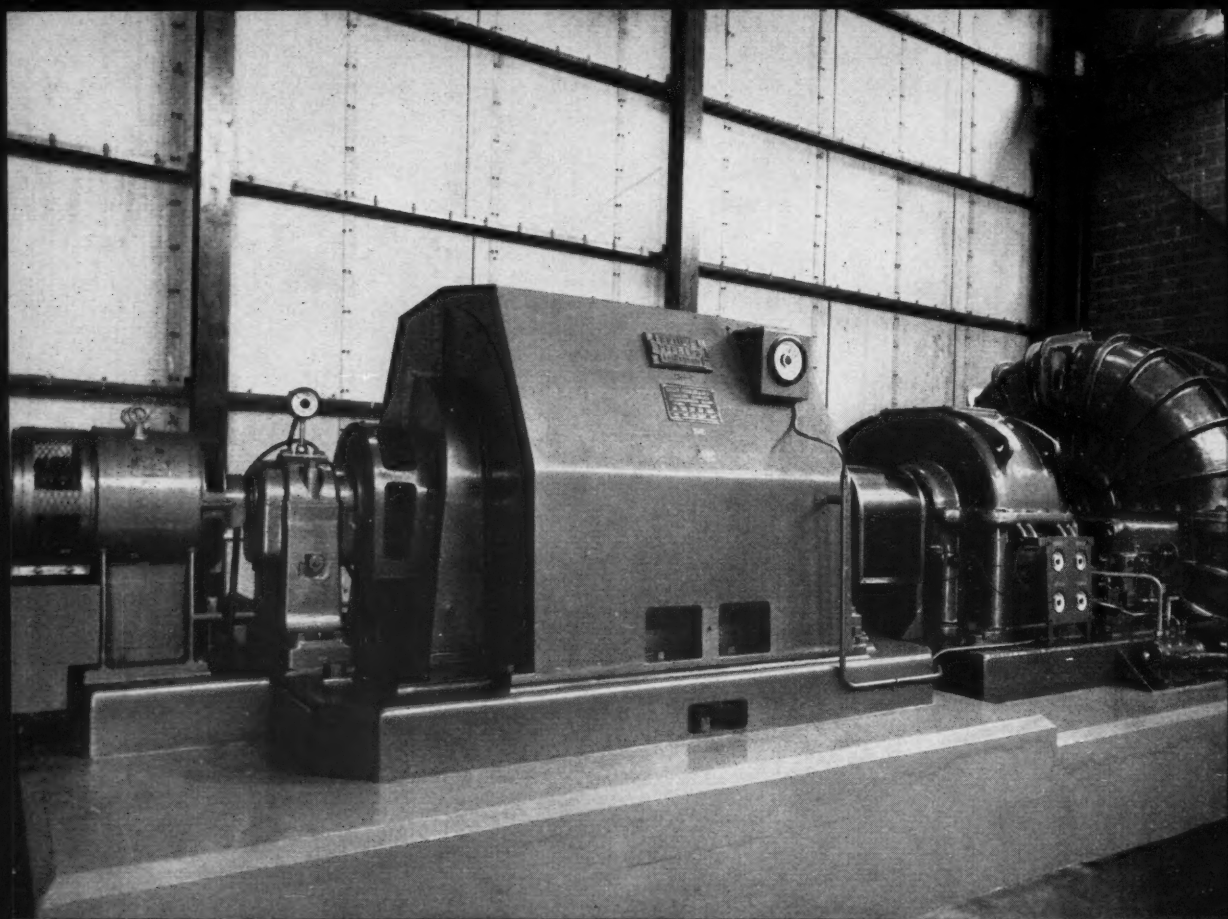


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Designews

APIDO

A step toward greater professional recognition has been achieved by Ontario industrial designers who have been issued a Provincial charter incorporating them as the Association of Professional Industrial Designers of Ontario. APIDO's first president is Mr. Ernest H. Orr, president of Orr Associates Limited, a Toronto industrial design firm. Directors of the new association are R. Bush, C. G. Sheperd, J. Esnor, J. F. Warren (see November Issue of DE), E. Orr, D. C. McCormack, and L. G. McIntosh.

The APIDO aims to assist qualified institutions to raise the standard of training of industrial designers and to foster a high standard of design in products of Canadian manufacture. The association is further interested in every aspect of industrial design with regard to consumer acceptance, convenience, fitness to purpose and appearance, as well as manufacturing processes.

TECHNICIAN REGISTRATION

The 1000th person to be certified under Ontario's engineering technician and technologist certification program, Mr. C. B. Alexander, of Islington, received his certificate from Labor Minister Charles Daley in a special ceremony in Mr. Daley's office.

The occasion represents a milestone in the growth of the certification program which was launched two years ago by the Association of Professional Engineers of Ontario.

The APEO was the first engineering body in Canada to establish a program whereby technically-trained persons are graded according to their education and experience into four categories. Already many industries in Ontario are classifying and paying their technical personnel according to these categories, just as they have done for years in the case of registered professional engineers.

Technicians play a very valuable role in engineering by assuming many of the non-professional duties of an engineer, thus permitting the engineer to carry out full-time professional work. The certification program serves to encourage the technician to improve his education and qualification, thereby increasing his usefulness to his employer and his contribution to the Canadian economy.

WHY AMERICAN?

The newly formed Border Chemical Company, of Winnipeg has announced that they retained the Chemical Construction Corporation of New York to design and engineer their new 50 ton Chemico Contact Sulphuric Acid plant currently under construction.

We are usually glad to read announcements of new Canadian firms and industrial expansion. In this case,

however, we are disappointed. We are disappointed because another Canadian firm felt it was necessary to go across the border to secure design and engineering services. Surely there are any number of Canadian design companies more than capable of undertaking the design of a sulphuric acid plant. If the management of the chemical company are unable to locate such service in Canada, the editors of DE would be only too happy to make some suggestions.

OVERNIGHT EXPRESS

Here is a story we heard recently of how British industry looks after its export trade—we wonder if any Canadian company would have gone to these extremes to keep a customer satisfied?

Late on a Friday night a telephone call came from Canada to the home of a factory manager in Devon, in the west of England. It was an urgent appeal for replacement parts for a sawmill. But the plant making the parts had just closed down for its annual two-week holiday.

So what happened? The works manager contacted a colleague, and about midnight he turned somebody out of bed in London—right away they got on the job at a London factory.

By noon the following day the parts had been produced, assembled, painted, packed and taken to the international airport in London.

The plane was met at Toronto by an agent of the company, and the parts rushed hundreds of miles to the sawmill which was idle for want of them.

So the machinery which stopped in Canada on a Friday was at work once more on Monday, with parts specially produced in London during the weekend. Of course, this whole event would have been circumvented if the sawmill had carried an adequate supply of spare parts—a lesson which many an operation has had to learn by bitter experience, with an ending not quite so happy as this one.


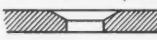
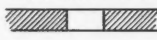
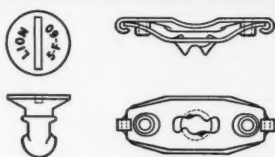
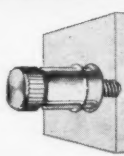
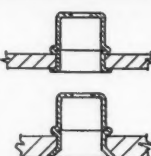
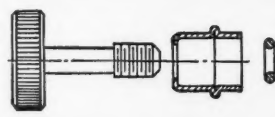
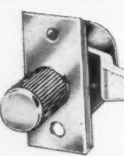

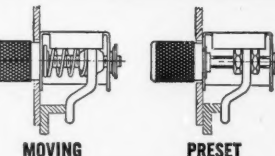
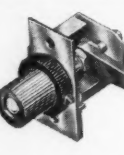
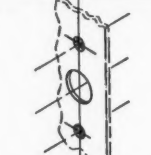
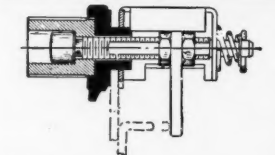


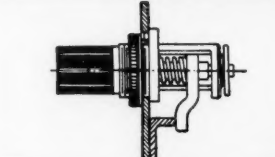

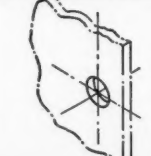
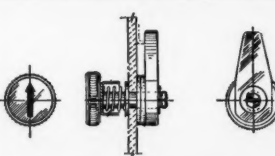
MC MASTER ENGINEERING BUILDING

The new three-story, 165-room engineering building at McMaster University in Hamilton, Ontario was officially opened by one of the deans of Canadian engineering, Dr. Kenneth F. Tupper, O.B.E. In his opening remarks, Dr. Tupper emphasized that "The important problems of the world today are not technological. We engineers and scientists must not shirk our share of responsibility simply by disappearing into the research lab, the design office and the factory and claiming to be too busy for these important things."

The courses of study at McMaster place a strong emphasis on the education of engineers for design and research work as well as for construction, production and maintenance. Engineering students will be required to carry out original design projects in their final year.

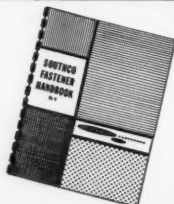
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	<p>LION 1/4 TURN FASTENERS</p> <p>Quick, positive locking, by fractional turn. Tight seal formed by compression of leaf spring. Alignment and stack height not critical. Approved for aircraft use. Rugged. Extra strength provided by swaged nose. Vibration resistant.</p>	<p>FOR COUNTERSUNK</p>  <p>FOR OVAL HEAD</p> 	
	<p>RETRACTABLE SCREW FASTENERS</p> <p>Stand-off thumb screws from stock to eliminate costly, special fasteners. Installed quickly without special tools. Accommodate misalignment. Complete range of standard sizes.</p>		
	<p>ADJUSTABLE PAWL FASTENERS</p> <p>Pre-assembled, quickly installed. Accommodate variations in frame thickness up to 1/2 inch. One-quarter turn closes, additional turns increase grip pressure. Attractive appearance, long life. Moving or pre-set pawl. Miniature, intermediate and large sizes.</p>		 <p>MOVING PRESET</p>
	<p>ADJUSTABLE PAWL FASTENER</p> <p>Has twin-knob control. One knob controls pawl, pointer shows pawl position. Other knob controls amount of pressure to seal closure with uniform pre-set compression. Easily installed.</p>		
	<p>ADJUSTABLE PAWL FASTENER</p> <p>Compact and rugged. Eliminates rivets or bolts to save installation time. Three types cover grip range up to 3/4". Supplied either with integral metal and plastic knob, plastic knob or for your knob.</p>		
	<p>ARROWHEAD DOOR LATCH</p> <p>Requires only one hole to install. Operates on quarter turn. Holds under spring tension. Arrow shows pawl position; no pawl stops required. Uses minimum inside space.</p>		

Free Fastener Handbook

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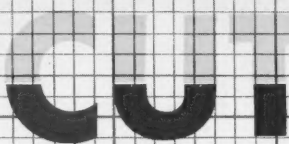
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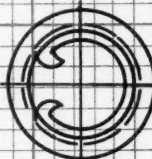
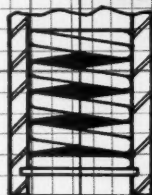
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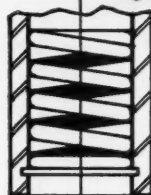
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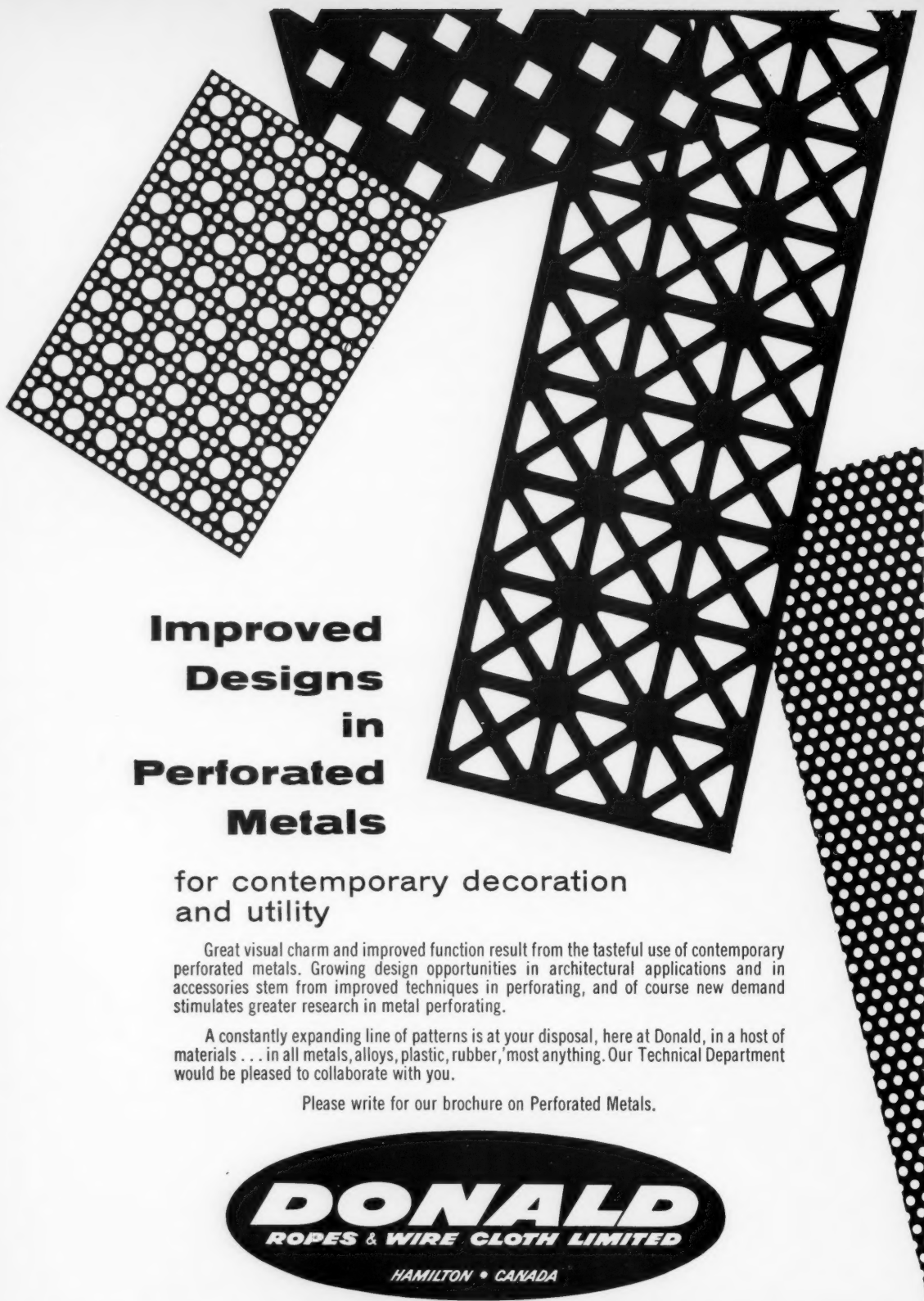
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A constantly expanding line of patterns is at your disposal, here at Donald, in a host of materials . . . in all metals, alloys, plastic, rubber, most anything. Our Technical Department would be pleased to collaborate with you.

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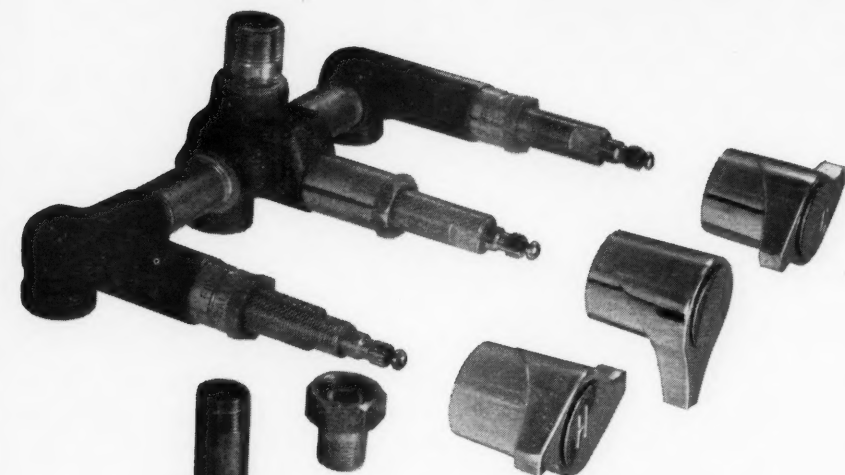


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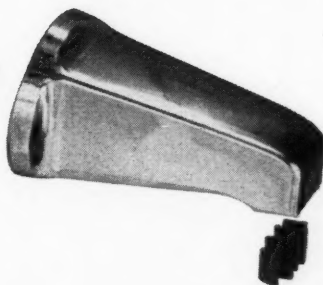
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D-79

**appearance
and dependability...**



NORANDA BRASS



More than a half century of manufacturing and designing experience stands behind the new Lustre-Line by Wallaceburg Brass Limited.

A special survey of housewives across Canada determined the choice of exterior (chrome-plated) controls for appearance and ease of operation.

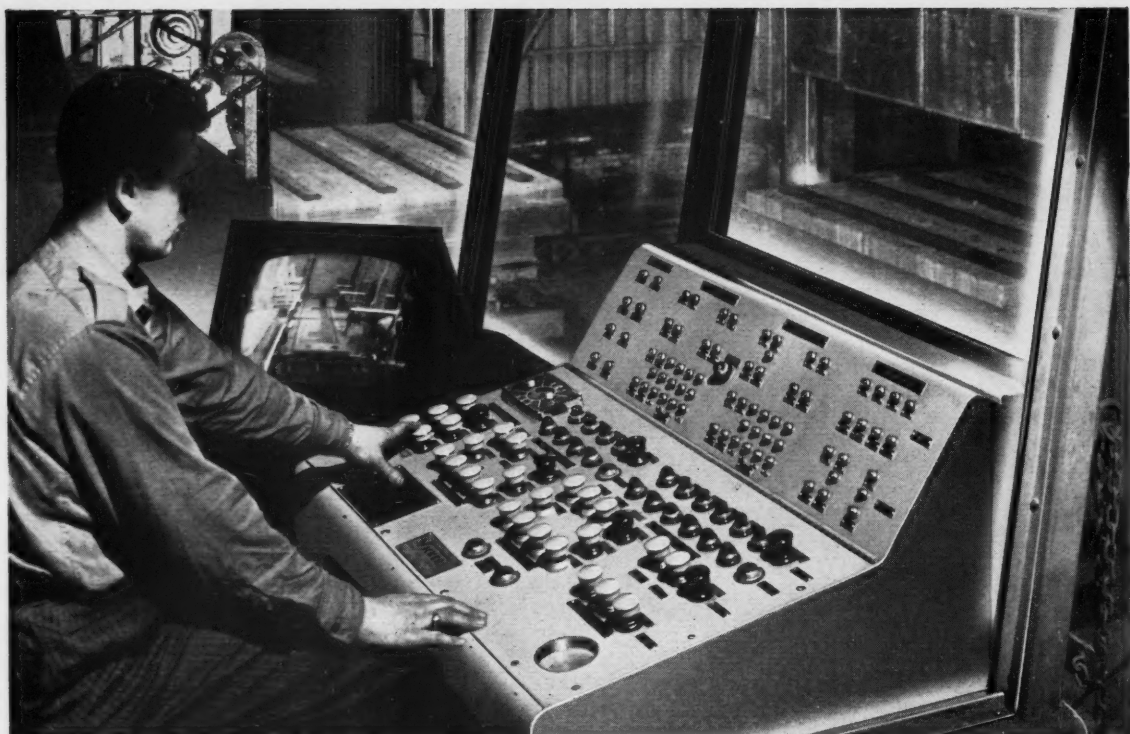
Noranda Brass was selected by Wallaceburg for the "working parts" of the entire fixture. Ease and speed of fabrication, corrosion resistance and consistent quality make Noranda copper and copper base alloys the outstanding choice for all your fabricating needs. Call your nearest Noranda sales office for information or technical assistance.

THE KEY TO THE BEST IN METALS

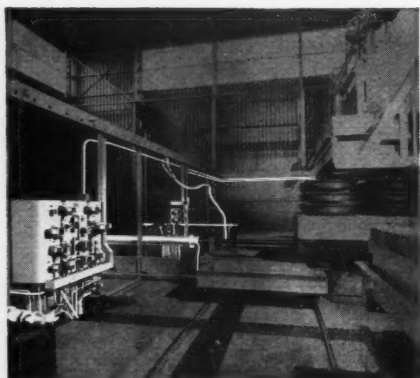
Noranda Copper and Brass Limited

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VICKERS® PACKAGED ELECTRO-HYDRAULIC SYSTEM makes possible automatic heat treatment at Canadian Steel Wheel



Vickers control console at top of page gives operator remote control of normalizing furnace operations. Control console, power units, and valve panels like the one shown above are all part of the Vickers-Sperry package.

A combination of closed circuit TV and electro-hydraulic control permits a fully automatic heat treatment cycle for wrought steel wheels at Canadian Steel Wheel Limited's ultra-modern plant in Montreal. Depressing a selector button is all it takes to initiate a cycle. This new integrated plant can produce 200,000 wrought steel wheels per year to meet the increased needs of Canada's railways. This is accomplished by using the latest in automated manufacturing procedures and inspection techniques.

Vickers-Sperry of Canada Ltd. designed and manufactured the complete electrical and hydraulic control system for movement of wheels through the 90-foot long heat treatment furnaces. The complete "packaged" job included installation and startup of the equipment.

Although Vickers-Sperry "Packaged Systems" like this one are developed for specific installations, they use standard components throughout . . . thereby cutting original cost and simplifying maintenance because spare parts and service are readily available. You get not only single source convenience but *single source responsibility*.

A Vickers-Sperry application engineer can survey your requirements and show you how a packaged electro-hydraulic system offers the most efficient solution to your operating needs. Further information is available in Bulletin 59-74, write for your copy today.

VICKERS-SPERRY of Canada Ltd.

Division of Vickers Incorporated

SPERRY RAND CORPORATION

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USE OF ALLOY IRON ENSURES...

*accurate casting
longer life
greater economy*



Canada Iron produced these Crusher Rings in Ni-Hard alloy iron for a leading Canadian chemicals producer. The bore and keyway were cast to size in this unmachinable material with *sufficient accuracy* to permit assembly on a carrier drum within prescribed tolerances. The Ni-Hard Crusher Rings last *twice as long* as the chilled cast iron rings previously used.

Close tolerances in casting are no difficulty for the Canada Iron metallurgist and foundryman. Many years of valuable experience in producing all types of rings, gears, bushings, plates, sheaves . . . in the *right metal* for the job . . . are at your service from Canada Iron laboratories and foundries.

Take advantage of this complete technological service. Let us show you what economies you gain when you have the best casting . . . a Canada Iron casting. Call today and discuss your needs with our sales representatives.



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CASTINGS**

CANADA IRON FOUNDRIES, LIMITED

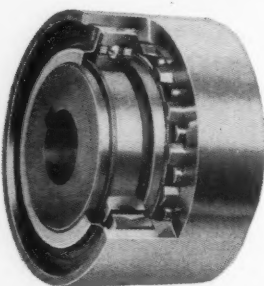
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product news from — United Steel CORPORATION LIMITED

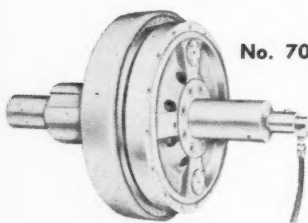


No. 701

Morse Cam Clutch

The action of the Morse Cam Clutch can be compared to a self-contained ratchet with an infinite number of teeth. They are available in five series:

- (1) **P.B. series**—medium or slow speed indexing and backstop applications.
- (2) **H.T. series**—especially designed for indexing, it can also be used for general duty or backstop.
- (3) **M.C. series**—for high speed overrunning and backstop applications as well as for heavy duty indexing.
- (4) **K. series**—for heavy duty overrunning, backstop, and indexing applications.
- (5) **20 series**—a low cost unit for backstop and indexing.



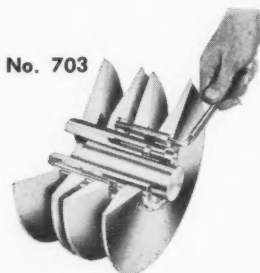
No. 702

Dodge Air Grip Clutch is most sensitive, responsive air clutch available.

The compact new Dodge Air Grip Clutch is the most sensitive, responsive air clutch available. The clutch may be "inched" or thrown into full engagement, as required. The air seal disc is so located that it does not contact the heat generating plates. This, together with internal ventilation makes for cooler operation and longer life. Quick release valves can be supplied where instant disengagement is desired.

Variable sheave provides quick, easy one-point adjustment

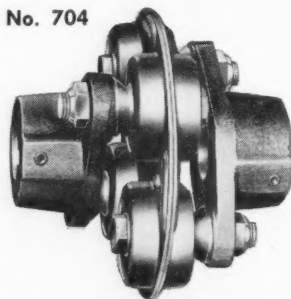
The Dodge Variable Speed Drive uses this compact variable sheave for quick, easy, one-point adjustment. All parts lock or unlock as a unit—positively, easily. Pitch diameter setting can be read directly on dial. Units are dynamically balanced for true running-operation.



No. 703

Coupling protects against shock, vibration, uneven torque impulses.

The Morse Morflex Coupling provides protection from shock, vibration and uneven torque impulses. The neoprene preloaded biscuit assembly is designed for uniform stresses and linear deflection. It eliminates metal to metal contact between driver and driven members, requires no lubrication, is unaffected by dust, dirt and weather. Available in stock bores from $\frac{1}{4}$ " to $2\frac{1}{8}$ " plain, keyway and setscrew.

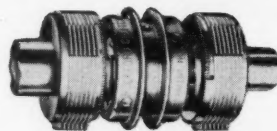


No. 704

Disc clutch is ideal where there are space limitations.

The Morse Pullmore Multiple Disc Clutch is ideal where design space limitations are important, because it transmits heavy loads in comparison to the clutch diameter. Double units may be applied to obtain forward and re-

verse movement, high and low speeds or for use as a clutch and brake. Capacities range from 1 to 90 H.P. at 500 R.P.M.

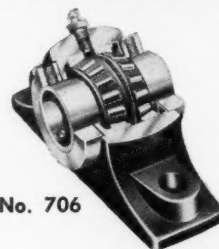


No. 705

The Dodge-Timken Type E Pillow Block

Offers many advantages including ruggedness, high speed capacity, positive locking to the shaft and low price.

The housings are as compact as they can be made without sacrificing the ruggedness which is characteristic of all Dodge Roller Bearings. These bearings have high radial and thrust load carrying capacities and are capable of handling most combinations of loads found in normal applications.



No. 706

All of these items illustrated here are available for immediate delivery from stock at United Steel Corporation. These are just a few items from our tremendous range of mechanical power transmission equipment. Our warehouses are located at strategic points across Canada. Our staff of transmission experts is ready and waiting. Drop us a line or fill in the coupon below for an answer to your transmission problems.

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ASK ANACONDA

for the answer to your metal problems



AIR COILS MFG. CO. LTD. did...



When heating and cooling coils were required for air conditioning units in the Navy's destroyer escorts, specifications were rigid.

For example, tubes had to have superior resistance to corrosion, particularly from salt brine. It was necessary to minimize the danger, through leakage, to vital electronic equipment. Every precaution had to be taken against the possibility of repairs in hard-to-reach, cramped quarters.

Air Coils Mfg. Co. Ltd. was awarded the contract. Anaconda supplied the chosen metal—cupronickel. In the photograph, Mr. E. G. Pullen (left) President, Air Coils Mfg. Co. Ltd., Mr. H. S. Litchfield (right) Vice President in charge of Design and Operations and Mr. W. C. Farrow

(centre) Anaconda Sales Representative, examine blueprints for one of the installations.

Here is another example of how Anaconda co-operates with Canadian industry in the solution of production problems through the application of copper and its alloys.

ANACONDA *

C-5940

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For general information on Anaconda Copper and Copper Alloys, write for publication B-32.

Anaconda American Brass Limited,
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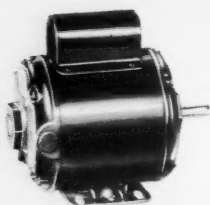
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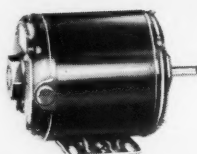
Select the right motor from

SINGLE PHASE MOTORS



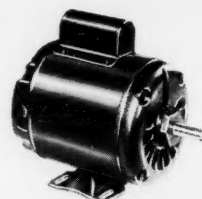
Type RK, RKJ, RKR—Capacitor Start

- Standard protected—48 frame
- Sleeve or ball bearing
- Rigid or resilient mounting
- 1/6 to 1/3 H.P.
- 115 volts, 1800 or 3600 rpm.



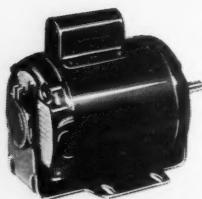
Type RB, RBJ, RBR—Split Phase

- Standard protected—48 frame
- Sleeve or ball bearing
- Rigid or resilient mounting
- 1/6 to 1/3 H.P.
- 115 volts, 1800 or 3600 rpm.
- Recommended for easy to start loads.



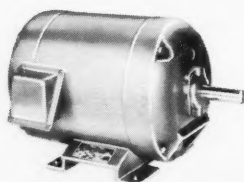
Type RK, RKJ—Capacitor Start

- Standard protected—56 frame
- Sleeve or ball bearing
- Available in 1/2 and 3/4 H.P.
- 115/230 volts, 1800 or 3600 rpm.
- General purpose motor for medium to heavy starting loads.



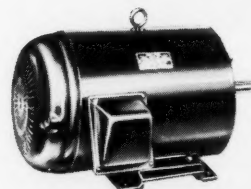
Type RKR, RKH—Capacitor Start

- Standard protected—resilient mount
- Sleeve or ball bearing
- Available in 1/2 and 3/4 H.P.
- 115/230 volts, 1800 or 3600 rpm.
- General purpose motor for medium to heavy starting loads.



Type RA-RAJ—Repulsion Start

- Standard protected
- Sleeve or ball bearing
- Available up to 5 H.P.
- 115/230 volts, 1200 rpm., 1800 rpm.
- For continuous heavy duty applications.

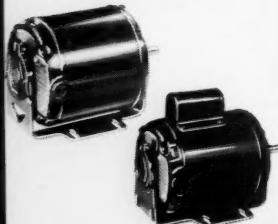


Type CAJ—Totally Enclosed Fan-cooled

- Ball bearing
- 1 to 5 H.P., 1800 rpm.
- 115/230 volts
- For severe atmospheric conditions, e.g. dust, dirt, abrasives, farm and chemical plants.

APPLICATION ENGINEERED MOTORS—with thermal protection

BELTED FAN For Heating and Air Conditioning Fans



Type RBR-2—RKR-2

- Standard protected 48-56 Frames • Sleeve bearing—resilient mounted • 1/2 H.P. to 1/3 H.P. split phase • 1/2 and 3/4 H.P. capacitor start • 115, 115/230 volts, 1800 rpm.

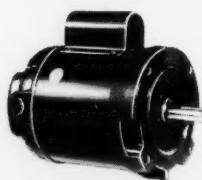
SUMP PUMP For Quiet Installations



Type RBV-2

- Standard protected, 48 Frame
- Ball bearing • 1/4 H.P. and 1/2 H.P. • 115 volts, 1800 rpm.

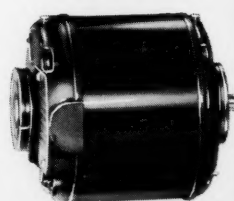
JET PUMP A High Efficiency Motor for Water Systems



Type RBV—RKV

- Standard protected—NEMA "C" face mounting 48 & 56 Frames • Ball bearing—3600 rpm. • Vertical or horizontal applications • 1/2 H.P. to 2 H.P., 115, 115/230 volts.

CIRCULATOR PUMP Designed for Hot Water Heating Systems



Type RBR-3—RKR-3

- Standard protected 48 & 56 frames • Sleeve bearing—resilient mounted • 1/10 H.P. to 1/4 H.P. • 115, 115/230 volts, 1800 rpm.

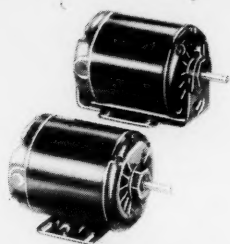
Correct type of motor and proper horsepower are most important

It cannot be stressed too strongly the advisability of consulting with a motor expert on the selection of the right type and horsepower for every electric motor application.

Wagner Engineers will be very pleased to work with you. There is no obligation of course.

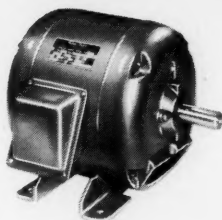
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THREE PHASE MOTORS



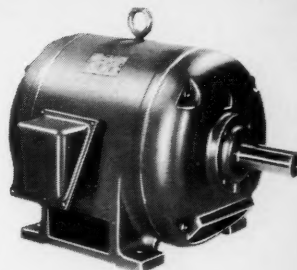
Type RP-RPJ-RPR—56 Frame

- Standard protected
- Sleeve or ball bearing
- Rigid or resilient mounted
- 1/4 H.P. to 1 H.P.
- 208/220, 440, 550 volts
- In all standard speeds.



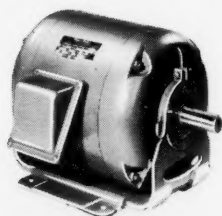
Type RP-RPJ—Standard Protected—Rigid Mount

- Sleeve or ball bearing
- Re-rated frames 182 to 215
- Available in 1/2 H.P. to 7 1/2 H.P.
- 550, 208, 220/440 volts
- In all standard speeds.



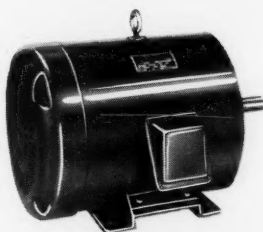
Type RP-RPJ—Standard Protected—Rigid Mount

- Sleeve or ball bearing
- Re-rated frames 254U-286U
- 3 H.P. to 20 H.P.—208, 220/440 550 volts
- In all standard speeds.



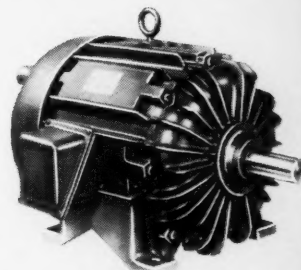
Type RPR—Standard Protected—Resilient Mount

- Sleeve bearing
- Re-rated frames 182 to 215
- Available 1/2 H.P. to 5 H.P.
- 208, 220/440, 550 volts, 1200 and 1800 rpm.



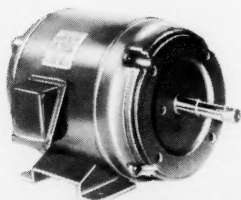
Type CPJ—Totally Enclosed Fan-cooled

- Ball bearing
- Re-rated frames 182 to 215
- 1/2 H.P. to 7 1/2 H.P.—208, 220/440, 550 volts
- In all standard speeds.



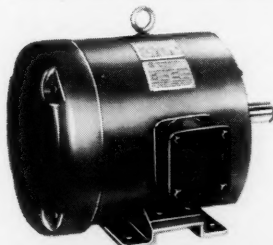
Type CPJ—Totally Enclosed Fan-cooled

- Ball bearing
- Re-rated frames 254U-286U
- 3 H.P. to 20 H.P.—208, 220/440, 550 volts.
- In all standard speeds.



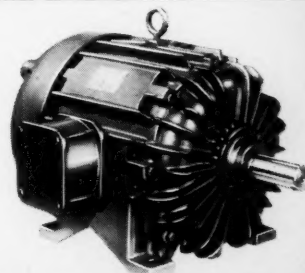
Type RPJ—NEMA "C" Face Mounted

- Ball bearing
- Re-rated frames 182-286U
- Available 1/2 H.P. to 20 H.P.
- 208, 220/400, 550 volts
- In all standard speeds.



Type HPJ—Explosion-proof—for Class I Group D and Class II Groups F & G—Totally Enclosed Fan-cooled

- Ball bearing
- Re-rated frames 182 to 215
- 1/2 H.P. to 7 1/2 H.P.—208, 220/440, 550 volts.
- In all standard speeds.



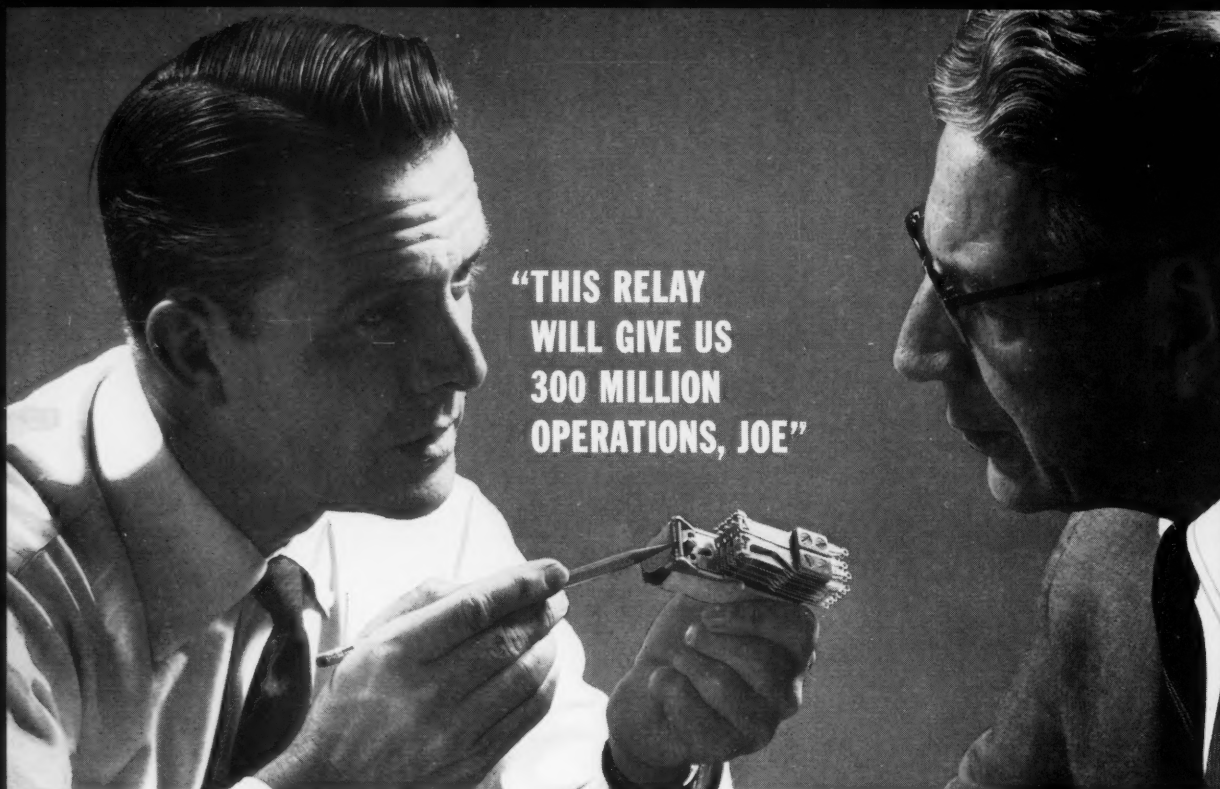
Type HPJ—Explosion-proof—for Class I Group D and Class II Groups F & G—Totally Enclosed Fan-cooled

- Ball Bearing
- Re-rated frames 254U-286U
- 3 H.P. to 20 H.P.—208, 220/440, 550 volts.
- In all standard speeds.

Wagner Electric

DIVISION OF SANGAMO COMPANY LIMITED

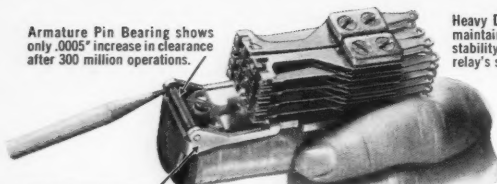
- Head Office—Leaside, Toronto 17, Ontario
- Plants at Leaside, Ontario and Trois Rivieres, P.Q.
- Sales Offices—Toronto, Montreal, Winnipeg, Edmonton



**"THIS RELAY
WILL GIVE US
300 MILLION
OPERATIONS, JOE"**

HERE'S WHY P&B TELEPHONE TYPE RELAYS GIVE YOU **reliable performance over long life**

Armature Pin Bearing shows only .0005" increase in clearance after 300 million operations.



Husky Armature Arm prevents sagging or bending.

BS SERIES TELEPHONE TYPE

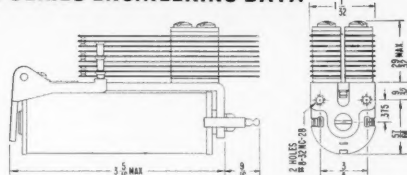
Measure the thickness of the BS series armature arm. You will find the cross section area is greater than ordinary relays of this type. Here is the kind of quality that spells dependability.

Observe that the stainless steel hinge pin runs the full width (not just half) of the armature, providing optimum bearing surface. This pin, operating in a stainless steel sleeve, shows only minimal wear during nearly a *third of a billion operations*.

Best of all, P&B quality costs no more. A whole new plant is being devoted to the production of high performance telephone type relays. Your nearest P&B sales engineer will be happy to discuss your relay problems. Call him today.

Heavy Duty Frame maintains dimensional stability, adds to relay's sensitivity.

BS SERIES ENGINEERING DATA



GENERAL:

Breakdown Voltage: 1000 volts rms 60 cy. min. between all elements.

Ambient Temperature: -55° to +85° C. +125° C available on special order.

Weight: 9 to 16 ozs.

Terminals: Pierced solder lugs;

Coil: One #16 AWG wire

Contacts: Two #18 AWG wires

Enclosures: Dust covered or sealed

CONTACTS:

Arrangements: DC—up to 28 springs

AC—up to 24 springs

Material: 1/4" dia. twin palladium.

Up to 1/4" dia. single silver.

Other materials on special order.

Load: 4 amps at 115 volts, 60 cycle resistive

Pressure: 15 grams minimum

COILS:

Resistance: 100,000 ohms maximum

Current: 10 amps maximum

Power: DC—50 Milliwatts per movable arm.

Greater sensitivity on special order.

AC—17.9 volt-amps.

Duty: Continuous

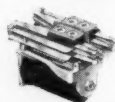
Treatment: Centrifugal impregnation

Voltages: DC—up to 300 volts with series

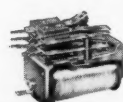
resistor. AC—up to 250 volts, 60 cy.

MOUNTING: Two #8-32 tapped holes 3/4" o.c.

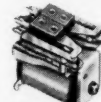
Other mountings on special order.



GS SERIES—Excellent sensitivity: 50 mw per movable arm minimum (DC). For applications requiring many switching elements in small space.



LS SERIES—Medium coil relay with short springs and light weight armature for fast action, reliability and long life.



TS SERIES—Short coil relay is available in AC and DC versions. Long life construction. Can be supplied (DC) with up to 20 springs (10 per stack).

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD CANADA LTD.

GUELPH, ONTARIO

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VIBRIN

*molds better products
more economically!*



Signs of the Times in VIBRIN

Outdoor signs seem to be fair game these days for sling-shots, airguns or any pitching arm with nothing else to do. Add natural damage by extreme temperatures or rusting rain, and you'll see why Customold Plastics Limited, of Montreal, turned to VIBRIN for *signs of life*... long life!

VIBRIN is a polyester resin reinforced with glass fibre. It's rustproof, weather-proof, and stronger than steel. Every day it's improving on metal and wood in a multitude of products which include: furniture, building materials, watercraft, aircraft, and even railway locomotive parts.

You'll like the way VIBRIN needs neither heat nor pressure, and only the most inexpensive molds.

Naugatuck technical representatives are at your service, and the facilities of our development laboratories are available to help you evaluate Vibrin — and to improve present products or to create new ones. Simply contact Naugatuck Chemicals at Elmira, Ont., or our branches in Montreal, Toronto, Winnipeg or Vancouver.

Other NAUGATUCK Plastics

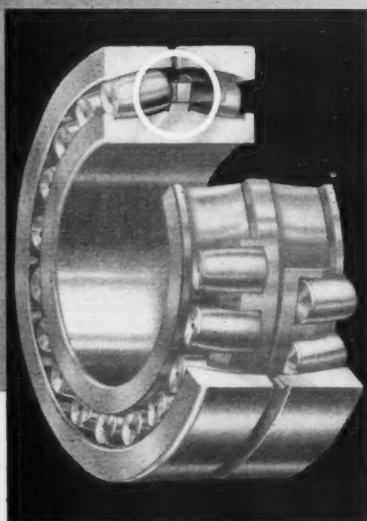
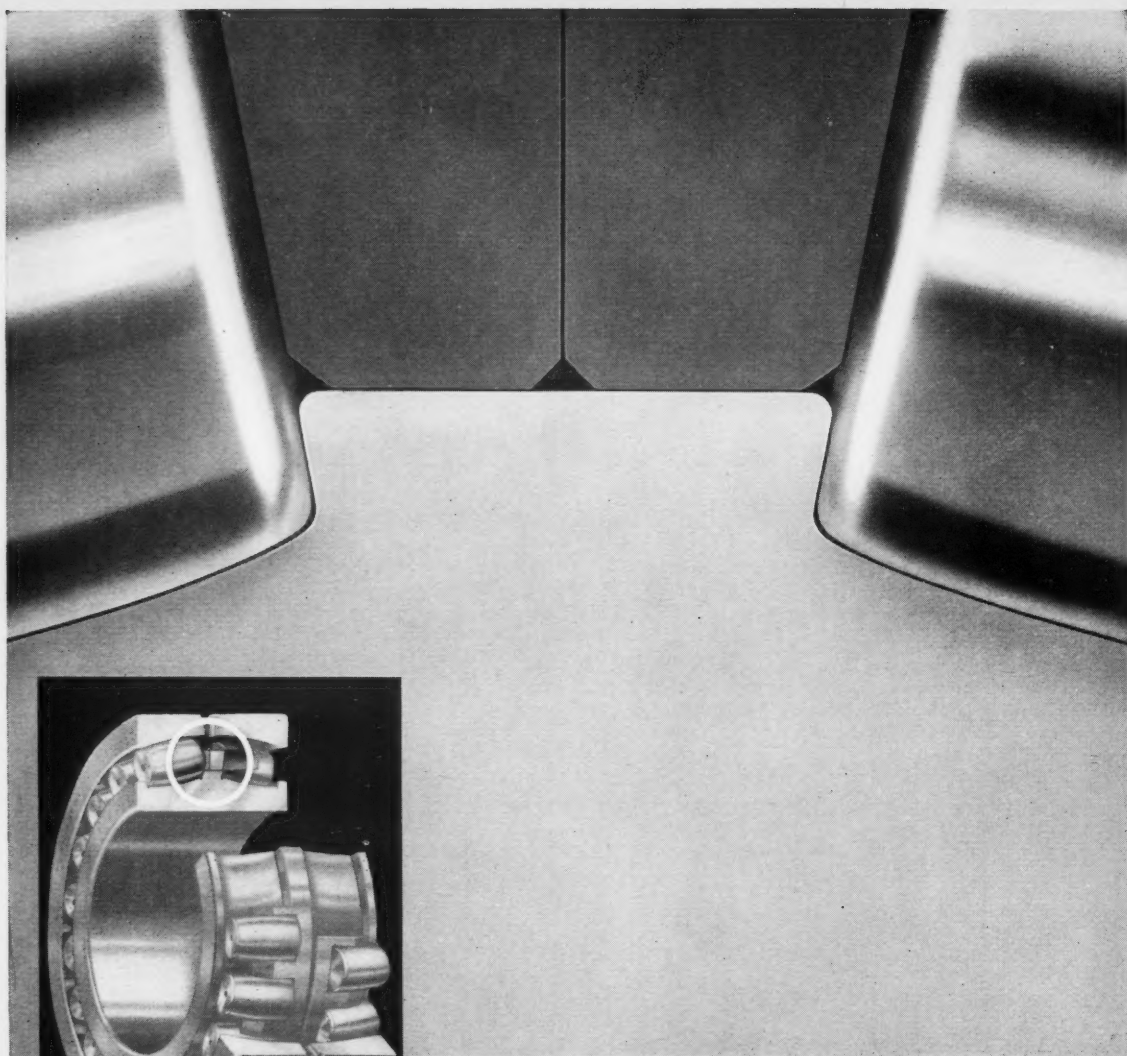
Vibramix — Polyester Premixes
Kralastic — Styrene Copolymers
Marvinol — Vinyl Resins



Naugatuck Chemicals

DIVISION OF DOMINION RUBBER COMPANY LIMITED

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TORRINGTON
Spherical Roller Bearings Offer:

- inherent self-alignment
- conformity of rollers to raceways
- integral center guide flange for stability
- positive roller guidance
- land-riding bronze cages
- maximum radial and thrust capacity
- controlled internal clearance
- electronically selected rollers
- even load distribution
- long, dependable service life

Send for new Torrington
Spherical Roller Bearing Catalog #258.

Keystone of Stability!

The integral center guide flange of the *Torrington* Spherical Roller Bearing provides *positive* roller guidance—the one best way to insure operating stability under radial and thrust loads.

Center guide flange surfaces and roller ends are ground to a common spherical radius. The asymmetrical roller seeks this flange under load, bearing lightly but constantly against it. Roller wobble and skewing are eliminated, and stress concentrations leading to early failure are avoided. Bearing operation is cooler, quieter and smoother.

The integral guide flange is adapted from the same principle used in the design of *Torrington* Tapered Roller Bearings. It is an engineering refinement, based on experience in all types of applications, that insures outstanding performance in your equipment. **The Torrington Company, Limited, 925 Millwood Road, Toronto 17, Ontario.**

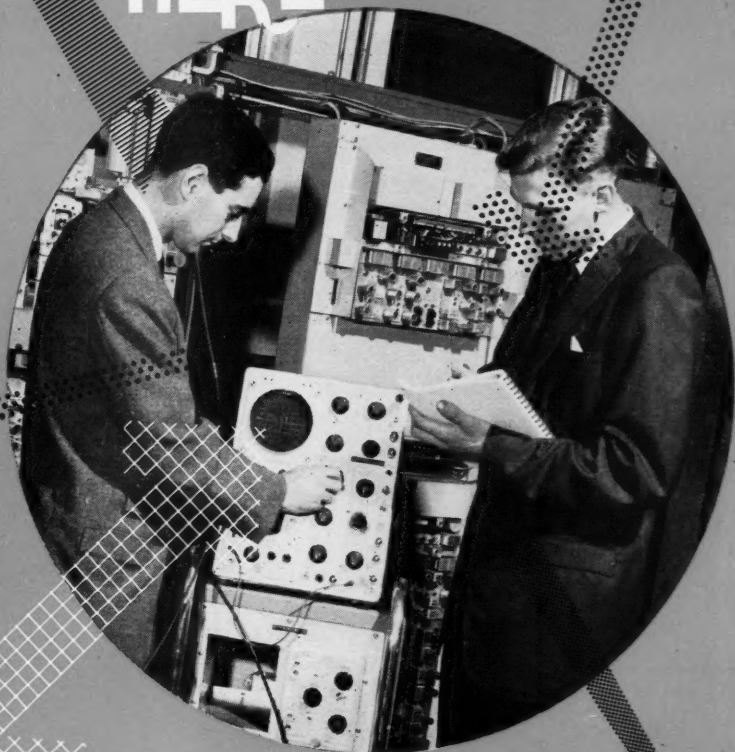
TORRINGTON BEARINGS

Every Basic Type of Anti-friction Bearing

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

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NEW VENTURES BEGIN HERE



In the modern laboratories of Northern Electric, new concepts in communications are constantly taking shape. Each project is approached with vigour, as a new and challenging venture, by a skilled research and development team — a group of men who keep their minds poised and eager to pioneer new techniques and improve established products — transistors, electronics, microwaves, carriers, video and audio.

At Northern Electric, research and development are setting the pace in the science of communications.

Research and Development Laboratories

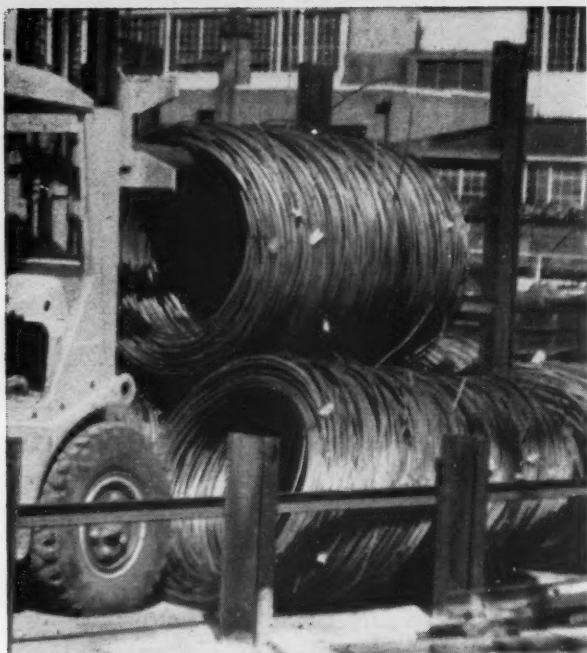
Northern Electric

COMPANY LIMITED

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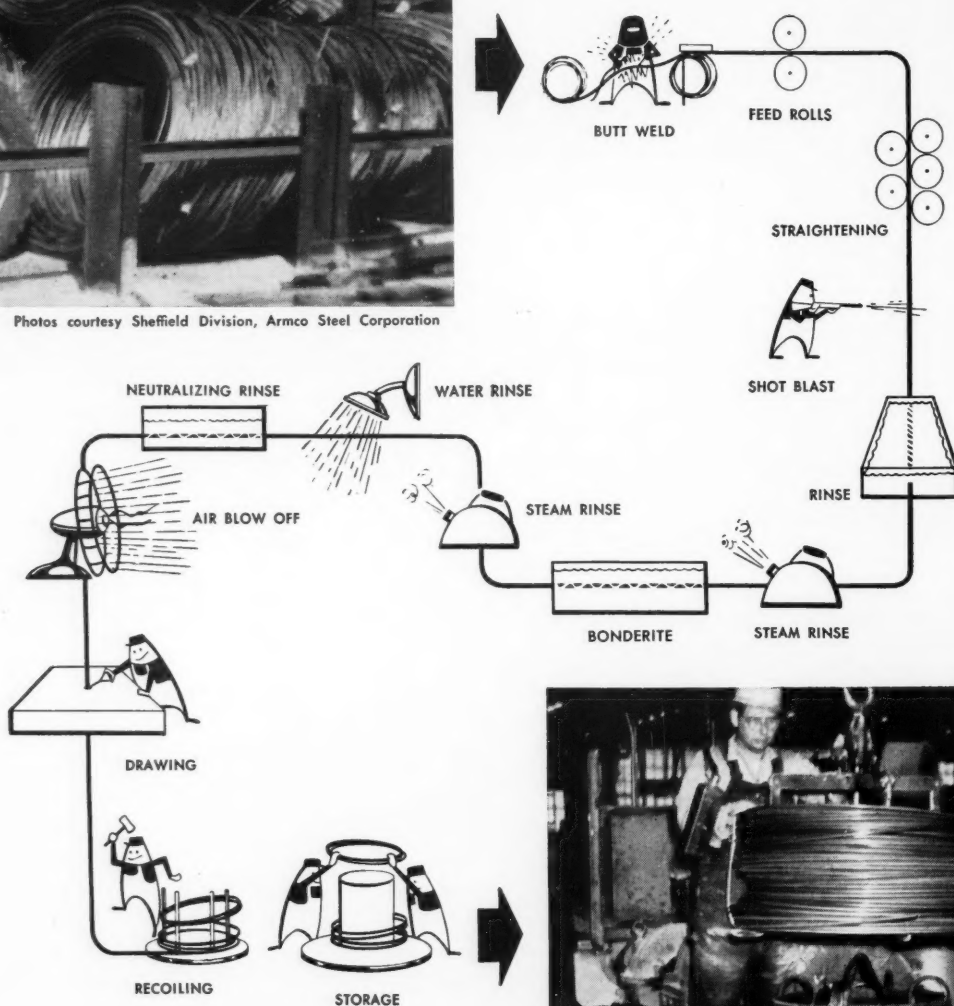
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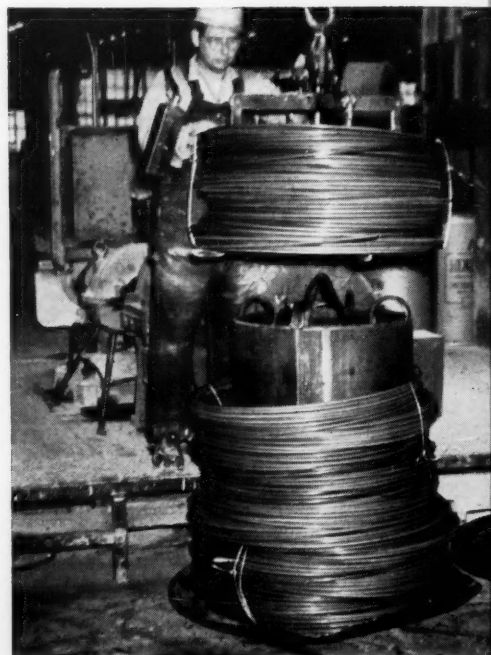


Photos courtesy Sheffield Division, Armco Steel Corporation

HOT ROLLED ROD—With Stran Bonderite in your plant, you can store rod in the yard. Schematic drawing shows processing.



SIZED OR FINISHED WIRE—Wire, finished with the aid of Stran Bonderite, is readied for storage before going to cold heading machines.



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STRAN BONDERITE

revolutionizes cold heading and high carbon wire drawing in a continuous operation

Now—with Stran Bonderite—Parker has scored another breakthrough, this time in cold heading and wet or dry high carbon wire drawing.

This revolutionary development treats rod or wire in a continuous strand, creating a uniform coating and lubrication in a few seconds as the strand moves at production speeds.

The Stran Bonderite system produces cleaner wire, eliminates acid disposal problems and saves space. All this is accomplished with substantial overall cost savings and reduced labor.

An added benefit is the increased corrosion resistance afforded by the Bonderite coating, even after it has been through the dies. Finished coils remain rust-free and ready for use.

COLD HEADING—Manufacturers who have installed the revolutionary new Stran Bonderite system are reporting these benefits:

- *Improved lubrication makes it possible to do more difficult jobs.*
- *Tool life is greatly improved.*
- *Better dimensional tolerances are held.*
- *Residual coating increases die life in thread rolling.*

HIGH CARBON WIRE DRAWING—Among the advantages of Stran Bonderite in wet or dry high carbon wire drawing are these:

- *Improved lubrication eliminates many of the problems in the production of drawn shapes.*
- *Stran Bonderite greatly increases die life which results in close dimensional tolerance over long production runs.*
- *The chemically applied coating retains lubrication more effectively to permit higher drawing speeds.*



Stran Bonderite is ready to save you money in your plant—and give you a better product. It has been thoroughly production tested.

We will be glad to tell you how it is saving money for many manufacturers today, how it will fit economically and efficiently into your operations. (Bonderite is also available for immersion application where conventional pickle house preparation is used.)

Write or call for expert help today!

Parker Rust Proof Company

OF CANADA LTD., REXDALE BLVD., REXDALE (TORONTO), ONTARIO

BONDERITE corrosion
resistant paint base

BONDERITE and BONDERLUBE
aids in cold forming of metals

PARCO COMPOUND
rust resistant

PARCO LUBRITE—wear
resistant for friction surfaces

TROPICAL—heavy duty
maintenance paints since 1883

*Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.

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WHEN AND WHERE TO USE

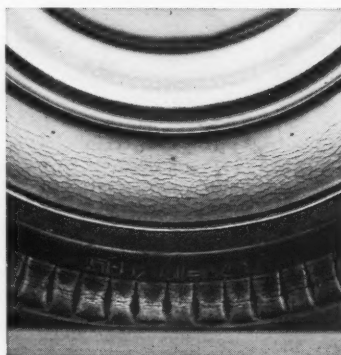
NEOPRENE

Made by Du Pont for 28 years, this synthetic rubber has demonstrated that it can be used with excellent results in a wide variety of applications. It meets many different service requirements and environmental conditions. Neoprene offers a balanced combination of properties not available in any other single elastomer. Neoprene not only offers desirable elastomeric qualities, but also offers good all-around resistance to many deteriorating influences. Because of these properties in combination, neoprene is being used in an ever-growing number of new applications.



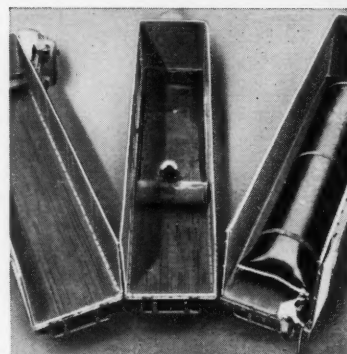
COMPRESSION SET

Neoprene sealing gaskets now solve the problems of air and water leakage through curtain-wall panel joints. Neoprene is weatherproof and trouble-free, applies sustained sealing pressure because of its low permanent compression set. Gaskets simply snap over panels, save installation time.



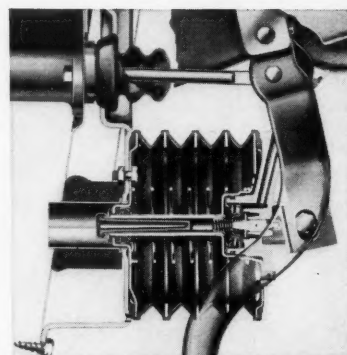
OZONE RESISTANCE

Tire sidewalls made with neoprene have now solved the problem of ozone cracking on the West Coast. Before neoprene, tires with only 30% tread wear often developed severe sidewall cracks. Now neoprene keeps sidewalls crack-free and new-looking for the life of the tire.



WEATHER RESISTANCE

Portable containers that hold large volumes of liquid, yet roll up into compact bundles, are now made practical by an outer covering of neoprene. Neoprene resists sunlight, weathering, ozone, oils and chemicals. In addition, it takes severe flexing without cracking.



FLEX FATIGUE

A neoprene bellows offers excellent resistance to flex-cracking in an automotive power brake unit. The bellows withstands 500,000 flexing cycles in standard tests. Neoprene also resists oils, temperature extremes, and provides good sealing by reason of its low permanent compression set.

HOW DUPONT ELASTOMERS COMPARE IN IMPORTANT PROPERTIES

RATING	PROPERTIES										
	RESILIENCE	RESISTANCE TO OXIDIZING CHEMICALS	HEAT RESISTANCE	OIL RESISTANCE	LOW TEMPERATURE PERFORMANCE	COMPRESSION SET	FLEX FATIGUE RESISTANCE	WEATHER AND SUN RESISTANCE	OZONE RESISTANCE	ABRASION RESISTANCE	ELECTRICAL
Excellent	Neoprene	HYPALON	Neoprene	Neoprene	HYPALON	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene
Good	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene
Fair	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene	Neoprene

Neoprene

HYPALON

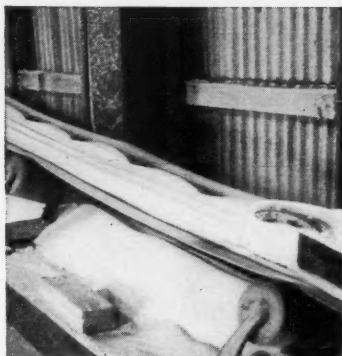
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DU PONT ELASTOMERS

HYPALON*

A relatively new DuPont elastomer, HYPALON has quickly won ready acceptance in heavy-duty as well as decorative applications. This synthetic rubber gives the designer a material that is ozone-proof and also highly resistant to sunlight, weather, oxidizing chemicals, abrasion and heat. HYPALON has an added advantage in that it can be compounded in unlimited colors—colors that are unusually stable to light and weather. For greater economy, HYPALON can often be compounded with other elastomers or applied as coatings over other materials.

Send the coupon today for technical assistance and publications describing Du Pont elastomers in detail.



ABRASION RESISTANCE

On a conveyor belt for 275-324° F. salt, a covering of ordinary heat-resistant rubber used to crack badly after only 3 months' service. A belt with a $\frac{1}{4}$ " cover of HYPALON, however, was in good condition after 6 months' service.



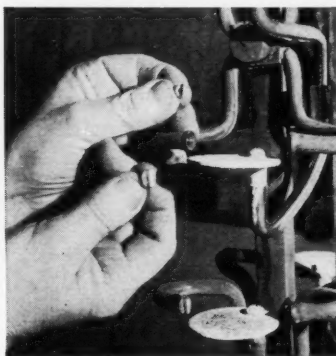
COLOR STABILITY

In a new gunwale guard, two HYPALON strips available in a variety of colors permit contrasting color combinations to match any boat. Because of HYPALON, the gunwale guard resists abrasion, oil, salt water and features unusual color stability to sunlight and weather.



HEAT RESISTANCE

HYPALON jacketing now permits ignition wire to withstand higher engine temperatures. This jacketing meets a heat aging requirement of 5 days at 275° F. plus peak temperatures above 300° F. HYPALON also prevents ozone cracking, resists corona cutting, abrasion, oils and chemicals.



CHEMICAL RESISTANCE

Now that metal plating racks are protected by HYPALON, the coatings last more than 12 times longer than plastic coatings. HYPALON offers exceptional resistance to plating solutions, withstands high temperatures without hardening, and resists abrasion during plating operations.



Better Things for Better Living
... through Chemistry

SYNTHETIC

RUBBER

NEOPRENE
HYPALON*
VITON*
ADIPRENE*

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- ☐ I am particularly interested in _____
- ☐ Send me a free copy of *The Du Pont Elastomers* (a review of properties of neoprene, HYPALON, and other synthetic rubbers.)
- ☐ Add my name to the free mailing list of the *Elastomers Notebook* (contains articles based on uses of Du Pont elastomers in industry).

DU PONT OF CANADA LTD.,
85 Eglinton Avenue East, Toronto 12, Ontario

Name _____
Firm _____
Address _____
City _____ Province _____

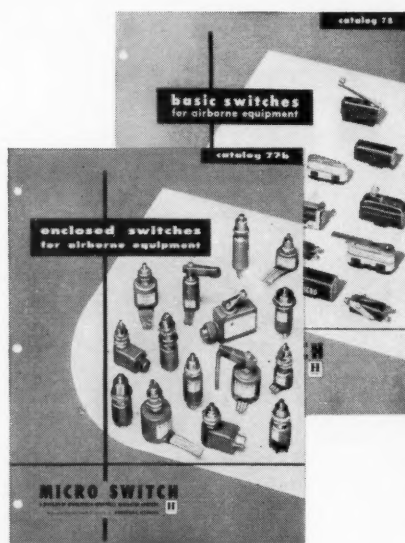
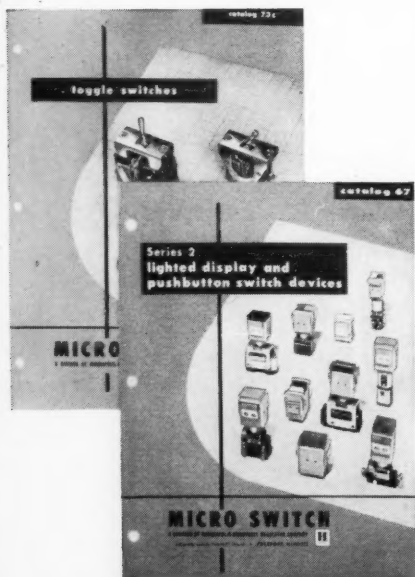
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For every switch requirement there's a MICRO SWITCH precision switch

with complete design information in these 9 catalogues

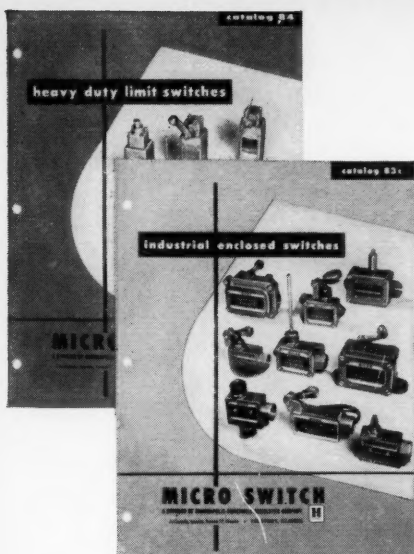
BASIC AIRBORNE SWITCHES are specially designed for use in airborne applications and can be installed in many different combinations of circuit, actuator and housing requirements. In addition, the characteristics of many of these switches make them suitable for use in automotive, transport or marine applications. Write for Catalogue 78.

AIRBORNE EQUIPMENT SWITCHES, enclosed in metal housings, include environment-proof switches, completely sealed against the effects of atmospheric changes, special roller-lever switches for exposed aircraft locations, hermetically-sealed switches and high-temperature switches which will maintain dependable operation in any temperature from -65°F to 600°F . A wide variety of circuitry and actuation is available. Write for Catalogue 77b.



TOGGLE SWITCHES from MICRO SWITCH are available as single switches or multiple assemblies, as subminiature or conventional-sized switches and with hermetic sealing where required by environmental conditions. And, of course, there is a wide variety of mounting arrangements, electrical and mechanical characteristics. Write for Catalogue 73c.

MICRO SWITCH SERIES 2 lighted display and pushbutton switches represent the most significant advance in the pushbutton control and indicating field. All Series 2 units present a uniform panel-front appearance. Units are mounted without tools, with five different colors available, in eight different mounting schemes. Switching and indicating functions can be combined, or kept separate, to provide unlimited flexibility in design. Write for Catalogue 67.



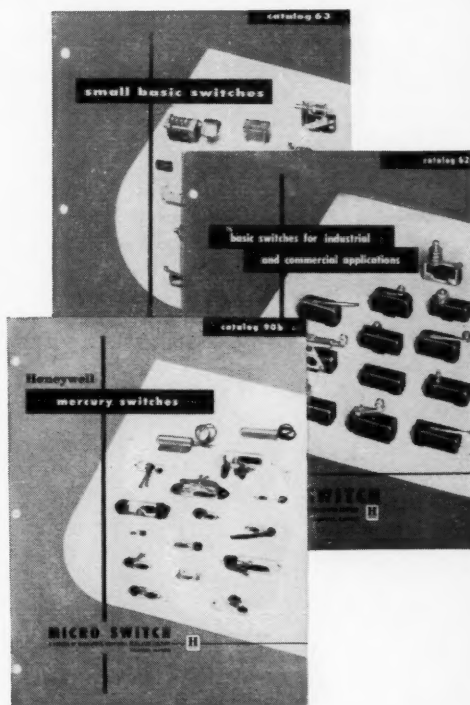
HEAVY-DUTY LIMIT SWITCHES are high capacity switches of extra-rugged construction and designed to stop a travelling mechanism at a predetermined point. Included is the famous "Plug-in Limit" switch that can be replaced in only 20 seconds and offers a choice of nine different actuators. Also available are explosion-proof limits and rugged models for applications where physical damage is possible. Write for Catalogue 84.

INDUSTRIAL ENCLOSED SWITCHES are precision snap-action switches in durable metal housings. Most have basic switches that are easily replaceable in the field and a wide range of actuating and mounting arrangements and electrical and mechanical characteristics. Included are explosion-proof, high-capacity, and general-purpose switches as well as hand and foot switches. Write for Catalogue 83c.

SMALL BASIC SWITCHES, often the size of a postage stamp or smaller, feature a long operating life and high electrical capacity for their size. These snap-action switches are available as "basics," with a host of different actuators, or as toggles, rotary selectors or push-buttons. Write for Catalogue 63.

BASIC SWITCHES can be used as limits, control switches and safety switches and are available in an almost unlimited number of different combinations of actuators, terminals and enclosures. They can be used alone, gang mounted, built into assemblies or enclosed in metal housings. Write for Catalogue 62c.

MICRO SWITCH MERCURY SWITCHES are often lower in cost than other types of switches and installation costs may also be lower because no operating mechanism is required. Mercury switches provide long, trouble-free operating life and are not affected by dust, fumes, spray or splash. MICRO SWITCH produces six basic types of mercury switches with more than 1,000 different designs. Write for Catalogue 90b.



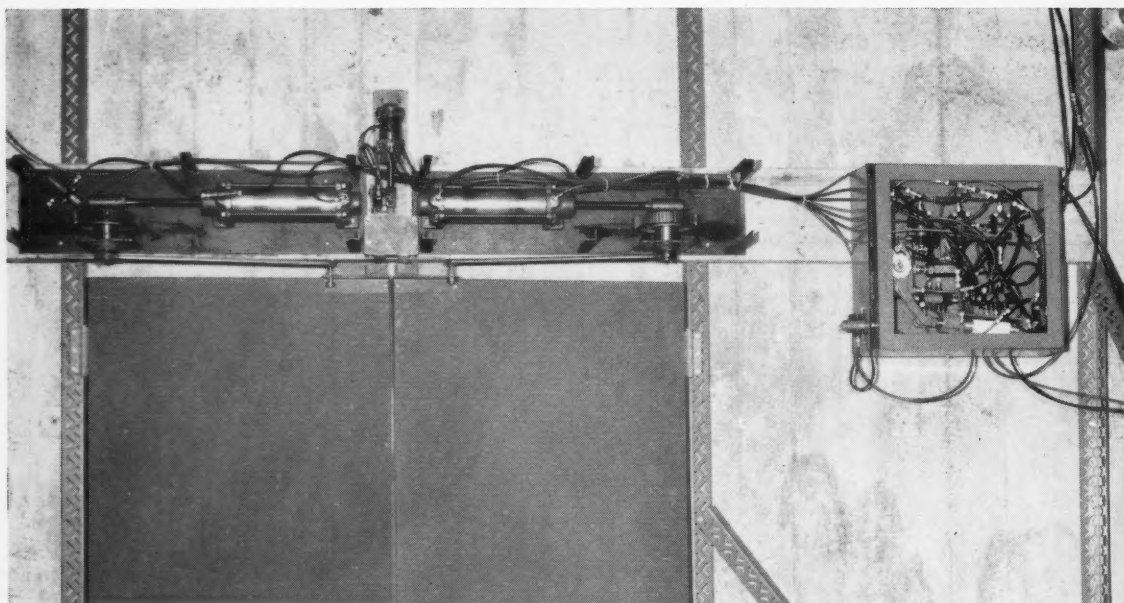
Write today for any, or all, of these MICRO SWITCH catalogues. All MICRO SWITCH precision switches are laboratory-tested from raw materials to the completed product to ensure long, trouble-free operation. And, of course, special switches can be designed for special requirements. There's a MICRO SWITCH for every switching need and your local Honeywell office is ready to give you expert technical service on any problem. Or write Honeywell Controls Limited, Precision Components Division, Toronto 17, Ontario.



Honeywell
MICRO SWITCH PRECISION SWITCHES

For information write direct to advertiser.

An open and shut case for **MAXAM** valves and cylinders



The twin doors at this Canadian film processing plant had to open automatically to admit personnel and equipment . . . close securely to black all light . . . and, most important, operate interdependantly so that one set was locked securely whenever the other was opened. MAXAM did the job!

Air powered Nopak cylinders, mounted above the doors, open and close them smoothly—on synchronized signals from the compact system of MAXAM valves shown at the right of the doorway. And MAXAM air power adds a safety feature—in the event of electrical power failure, air reservoirs contain sufficient reserves to open the doors for orderly evacuation. For full information on MAXAM pneumatic equipment—and for design assistance by pneumatic engineering specialists—write:



MAXAM-NOPAK DIVISION

HOLMAN BROS. (CANADA) LTD.

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For sales and service on MAXAM or NOPAK, contact: Suite 3, 1415 Lawrence Ave. W., Toronto or 8025 Decarie Blvd., Montreal

Match the motor to the job

The application comes first—rather than the motor this engineer suggests

The traditional approach to the problem of selection of motors has been to list all the possible types of motors, including standard and special motors. The equipment engineer or purchaser is then expected to select the type and rating best suited to the application.

In this article we propose to use as a starting point the types of applications rather than the types of motors. Then for any given type of application the most suitable motors and their construction features will be described.

Approximately 80% to 90% of all motor applications can be served by the standard lines of motors, the polyphase and single-phase motors which are normally listed in motor manufacturers' catalogues and stocked by them. The remaining applications involve special motors which cannot be selected readily from a catalogue. For these applications the motor manufacturer should be requested to make a study of the mechanical and electrical requirements and advise on the most suitable motors.

The standard line of motors

The standard line of motors usually offered in this country includes primarily a-c squirrel-cage induction motors constructed to meet the Motor and Generator Standards M-1 of the Canadian Electrical Manufacturers' Association (CEMA). These standards are very similar to those of the National Electrical Manufacturers' Association (NEMA) of the U. S. A., with certain

Exclusive DE Feature

Bruce F. Newman, P.Eng.

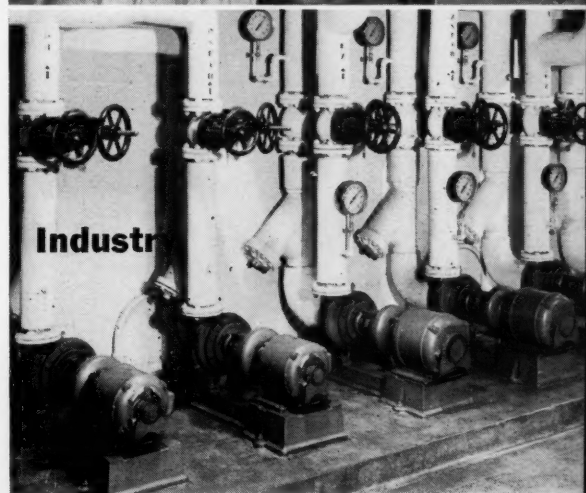
Mr. Newman is chief motor engineer of Wagner Electric Division of Sengamo Co., Leaside, Ont.



Consumer products



Machine shop



Industry

Match the motor *continued*

exceptions to suit Canadian conditions. They include data on the ratings, dimensions and description of mechanical features, along with limits for the motor performance values such as temperature rise, torques and starting current. They provide valuable background information for any motor purchaser.

The standard polyphase motors listed in the motor manufacturers' catalogues are CEMA standard general purpose induction motors known as Design B, with normal torque, normal slip and normal starting current. Mechanically they may be offered with either open (protected) enclosures or totally enclosed fan-cooled, and they normally have foot mounting, ball bearings and standard insulation.

Variations of these polyphase motors may be obtained with special torque characteristics, special enclosures, mounting, bearings or insulation.

The single-phase motors listed in most motor manufacturers' catalogues include split-phase and capacitor-start a-c motors, with perhaps also some ratings of shaded-pole, permanent-split capacitor or repulsion-start types. There are some motors listed for general-purpose application but nowadays the majority would be "definite-purpose" motors listed for specific types of appliances such as home-laundry equipment, oil burners, belted fans and others.

Motors for industrial applications

Industrial applications may be classified according to the general types of machinery:

Metal-cutting machines: Include lathes, milling machines boring machines, and drill presses. Standard polyphase motors are used for most of these machines, and often totally-enclosed fan-cooled motors are used to protect the motor windings from metal chips and cutting fluids. In order to obtain the correct machine speeds, various drive arrangements have been used, including gear drives, multi-speed motors and variable speed drives. There has also been some use of variable-speed d-c motors supplied from motor-generator sets or rectifier units, in order to obtain a wide speed range and accurate speed control.

In recent years the trend has been toward the use of built-in motors in machine tools. For these it is important to provide adequate accessibility and ventilation. There is also some use of face and flange-mounted motors. In general, these are more expensive than foot-mounted motors, but where they can be mounted on the end or face of the machine and the drive simplified, they may be an advantage. The dimensions have been standardized for face mounting (CEMA Type "C" mounting) and for flange mounting (CEMA Type "D" mounting).

Where severe repetitive duty cycles or rapid reversing are involved, such as in tapping operations, it is necessary to check the motor heating and either special insulation or special reversing-duty motors may be required.

Metal-forming machines: Include punch-presses and brakes. The same general considerations as above apply to these machines, but the load cycle usually includes a short-time peak. Standard motors may be used up to approximately 2 hp, but above this size they usually

should be high-torque, high-slip "punch-press" motors. These motors have high starting and accelerating torques to bring the machine and fly-wheel up to speed, and sufficient slip under load to allow the flywheel to contribute its stored energy toward that required for the peak load. This results in a smaller motor and more uniform current drawn from the line.

Wood-working machines: Include large saws, planers, sanders and other industrial wood-working machines. Totally enclosed fan-cooled motors should be used because of the sawdust involved, and these motors should be kept cleaned to provide proper heat dissipation.

Centrifugal pumps and compressors: Standard motors may be used but if they are in a damp location, the motors should have extra moisture-resistant treatment.

Reciprocating pumps and compressors: These should be arranged so that they start unloaded, in which case standard motors may be used. If it is necessary to start under load, then high starting torque motors are usually required, especially in sizes above 5 horsepower.

Fans and blowers: Standard motors may be used. If the motor is located directly in the air stream then a totally-enclosed "air-over" motor should be used. Where the atmosphere is contaminated, such as in a paint spray booth, the motor should be located outside the duct and belted to the fan.

Conveyors and hoists: For small conveyors and for continuously-running conveyors standard motors may be used, but for start-stop duty the motor should be a high-torque, high-slip intermittent rated type to match the duty cycle and provide smooth operation of the conveyor or hoist.

Chemical plants: Where moisture or chemical fumes are present, the motors should be ordered with extra treatment or materials to withstand the specified corrosive conditions. Where explosive vapours may be present approved explosion-proof motors should be ordered! It is not practical to build such motors completely vapour-tight and therefore as the motor heats and cools it will tend to "breathe" and will eventually draw the vapour into the casing. However, these motors are built with sufficient strength of materials and long fits so that any internal explosion cannot be transmitted to the surrounding atmosphere.

Grain mills: Totally enclosed motors should be used. In some locations where extremely fine dust is present it may be necessary to use approved dust-proof motors. These are a variation of explosion-proof motors; they have sufficiently long fits to keep the dust out of the motor and are designed to have surface temperatures low enough that the dust will not be ignited.

Special machines: For most industrial machines of sizes within the scope of this article (up to approximately 50 hp.) standard polyphase motors may be used, subject to the general precautions given in the comments above.

For machines used on a high-production line where down-time can be expensive, the use of standardized interchangeable motors is important, so that a reasonable stock of spare motors can be used to service the machines. This is considered by some large users to be sufficiently important that they have written into their equipment specifications a clause stating that only standard motors with standard mounting are to be used,



1. The author (second from right) with section colleagues examines some of the range of today's standard motors.

unless it can be proven that a special motor is essential for the operation of the equipment.

Motors for commercial application

Commercial applications include those in stores, office buildings, schools and gasoline stations. The machines to be driven include compressors, pumps and fans used for refrigeration, air-conditioning and other miscellaneous purposes. The chief differences between these applications and industrial applications are the need for quieter operation in many cases, and the power supply which may be single-phase.

For quiet operation, sound-isolating bases or mountings may be used and in some cases special sleeve-bearing motors may also be specified. For sizes of 1 hp and larger, polyphase motors should be used whenever possible, because of simplicity, lower cost and quieter operation. However, single-phase motors are generally available in sizes up to 5 hp.

Motors for farm applications

In farm applications there may be problems of moisture or dust, and moisture-resistant or totally-enclosed motors may then be required. However the main difficulty is usually that of obtaining an adequate power supply, especially for the larger sizes of motors. The power supply is usually single-phase and there may be relatively long primary and secondary lines.

It is important to use adequate wire sizes and transformer sizes to maintain the voltage at the motor terminals, and all motors of 1 hp. and larger should be connected on separate 230 volt circuits.

Motors for domestic or household applications

At one time so-called "general purpose" single-phase motors were used for household appliances but it has been found that they cannot include all the mechanical and electrical features required for proper operation of the various appliances. Therefore "definite-purpose" motors have been designed to suit the specific types of appliances. The standards for these motors are included in the CEMA Motor and Generator Standards and it is advisable to specify these standard motors whenever possible, since the motors are produced in volume by at least several manufacturers, resulting in lower cost and better availability.

One point which is not always considered is that American appliances may be designed to make best use of a specially-designed motor which is justified by their volume, while for the Canadian market a standard definite-purpose or appliance motor would be preferable both for manufacturing and for service.

The repair or servicing of the appliance should be considered in selecting the motor. Nowadays, the use of high-production machinery and special winding machines in the original manufacture of the motors often make it uneconomical to repair an individual

motor, since a complete new motor may be cheaper than the single hand-labour repair job. Also the inconvenience of down-time of the appliance while the motor is being repaired must be considered. Therefore the trend is towards the replacement of the motor for servicing, and it is important to use motors which will be readily available for this purpose.

All of this adds up to the conclusion that it is best to specify the standard definite-purpose motors as far as possible.

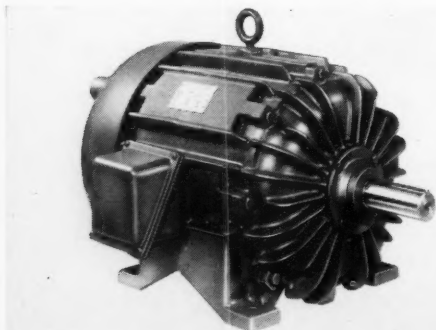
The construction and features required for motors used for different types of appliances include the following:

Home laundry equipment: The most common type of motor for washing machines and dryers is a split-phase motor rated either 1/4 or 1/3 hp, with high-torque characteristics. The noise level of these motors is not considered critical and the number of hours of operation are small, therefore they are designed with high flux densities, in order to achieve the high torque at minimum cost. The motors may be built with the normal protected enclosure or with wide-open skeleton construction if protected by the machine. They will normally have sleeve bearings, and resilient mounting using a cradle provided in the washing machine.

On this type of motor the resilient-mounting rings traditionally have been ungrounded in order to isolate the motor frame from the washing machine frame. The theory behind this is that with the use of 2-wire cords, a ground fault in the motor could make the motor frame "alive" and it has been felt that if the washing-machine frame were also made alive it would represent a shock hazard, especially with the laundry tubs and water pipes nearby. Alternatively, these motors have been supplied with a small static-drain resistor connected across the mounting rings when used with belt drives. The trend towards 3-wire grounded cords will probably change the requirements on these matters, since all non-current-carrying metal parts can then be grounded.

There is often no provision for adding oil to the bearings of these motors, on the basis that the original quantity of oil will be sufficient for the total number of hours of operation.

The introduction of automatic washing machines with spin-dry operation resulted in a problem of accelerating the large drum, and capacitor-start or specially designed motors have been used because of this. However, with a suitable clutch and drive arrangement the split-phase motors may be used.



2. Totally-enclosed, polyphase motor with cooling fins.



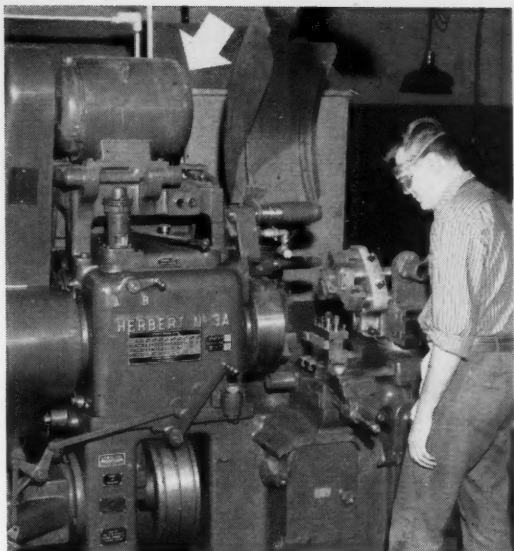
3. Sump pump, motor mounted, ready for installation.

Oil burners: The motors for the usual "gun-type" oil burners are split-phase motors rated from 1/2 to 1/6 hp, with electrical designs which provide low starting torque and quiet operation. These motors have flange mounting with 2 lugs for the mounting bolts, and either totally-enclosed or ventilated construction. Sleeve bearings are used to help provide quiet operation. The motors are equipped with a built-in manual-reset thermal protector, and the reset button is located in an accessible place on the end or top of the motor. The preferred lead location is at the drive end on the right hand side but this may be varied to suit the location of the ignition transformer or the connection box.

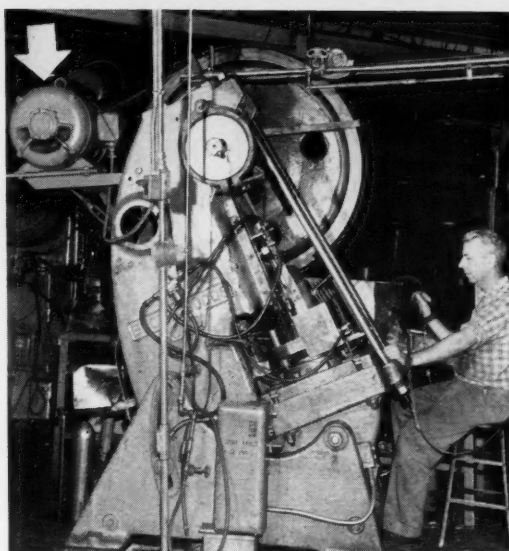
Belted fans: The most common belted fans are those for air circulation in forced-air heating systems. Belted fans may also be used for induced-draft or forced-draft application on coal-burning furnaces, and for large exhaust fans. The motors for belted fans are split-phase up to 1/3 hp and capacitor-start above this size. They are usually medium-starting torque designs and provide quiet operation. To assist in this, they have resilient mounting and sleeve bearings. The enclosure is the standard protected type, for operation in normal clean air. The motors are equipped with built in automatic-reset thermal protectors which will stop the motor in the case of overheating and will start it up again automatically when it has cooled to the reset temperature.

These motors should normally be mounted horizontally and with the frame rotated in the cradle so that the openings are drip-proof and the oilers facing up. For vertical operation such as required by some attic exhaust fans, special sleeve bearing motors may be used, or ball bearing motors may be installed if a somewhat higher noise level be permitted.

The belt drive must be tightened just sufficiently to drive the fan without slippage. This is often described as adjusting the belt so that it can be moved one inch either side of the normal position with the fingers. Many belted fans are constructed with a pivoted motor mounting so that the motor weight and torque automatically provide the correct belt tension.



4. Standard 20 hp, enclosed, fan-cooled motor on lathe.



5. Special high-torque, high-slip motor on punch press.

Direct-connected fans: For very small fans such as desk fans, shaded-pole motors are used, since they are the simplest and cheapest type up to approximately 1/20 hp. They are often constructed with sheet steel or die-cast aluminum cases and self-aligning light duty sleeve bearings. For a "deluxe" small fan with higher efficiency and quieter operation the permanent-split capacitor motor may be used. This type of motor has two sets of windings with a continuous-rated capacitor connected in series with one winding to provide the required phase displacement for both starting and running.

For direct-connected fans above those sizes, split-phase or permanent-split capacitor motors are used up to 1/3 hp and capacitor-start or permanent-split capacitor motors above 1/3 hp. The motors may be 1725 RPM (4-pole), 1150 RPM (6-pole) or 850 RPM (8-pole) to suit the requirements of fan speeds in order to obtain low blade tip speeds and quiet fan operation. These motors would all be low-torque quiet designs. The permanent-split capacitor motors would be somewhat more expensive but superior in this regard.

Where the motor is located directly in the air stream it should be specified as totally-enclosed "air-over". Since the motor will be cooled by the air stream it can then be designed electrically the same as an open motor, but it will not have any ventilating openings, which would become clogged by dust, dirt and lint. The motors for direct connected fans usually have resilient mounting. For horizontal operation they have sleeve bearings with provision for taking the axial thrust from the fan on the basis that the thrust is towards the motor, which means that the air flow is over the motor and then into the fan. For vertical operation or opposite direction of air flow, ball bearings are used.

Circulating pumps: Circulating pumps used on hot-water heating systems are small direct-connected centrifugal pumps which require very quiet-operating motors, since any noise is carried through the piping system. The motors are low-torque split-phase and capacitor-start motors with resilient mounting and sleeve bearings, similar to those used on direct-connected fans.

Sump pumps: Standard sump pump or cellar drainer consists of a vertical centrifugal pump with a long standpipe, on top of which the motor is mounted. This enables the pump to be located at the bottom of the sump, avoiding priming problems, with the motor located out of the water. The usual motor is a split-phase type rated 1/4 or 1/3 hp, arranged for vertical operation with appropriate bearing construction and arrangement of ventilation openings. The motor is machined to fit on the standpipe and includes a float switch and coupling.

Water-system pumps: Standard piston-type water pumps are belt driven from the motor. The motors are capacitor-start or in some cases split-phase high-torque motors. This is one application where the old "general-purpose" single phase motor may be used. The construction of the motors includes protected and dripproof enclosure, sleeve or ball bearings and rigid base mounting. They are equipped with built-in automatic-reset thermal protection.

Jet pumps: These are a type of water pump in which the motor is direct-connected to a centrifugal pump. This pump forces the water through a jet or Venturi-tube which then draws further water from the well. These pumps have the advantage of fewer moving parts than piston type pumps and also the Venturi can be placed at the bottom of a deep well.

The motors required for jet pumps are high speed, 3450 RPM (2-pole) motors, split-phase up to 1/3 hp and capacitor-start above this size. They are special designs with high running overload or service factors. This is necessary because the efficiency of the jet pump system is lower than that of a piston pump, yet for commercial reasons it is desirable to use the same hp rating on a pump of the same output capacity as the piston pump. The result is that the motor must be loaded more heavily on the jet pumps. The high service factors on jet pump motors are achieved by careful design of the ventilation system of the motors.

These motors are constructed with open protected

Match the motor *continued*

enclosure, ball bearings and face-type mounting. They are available with standard shaft extensions or with an alternative threaded shaft for mounting the impeller. Automatic-reset thermal overload protection is provided.

Refrigeration and air conditioning: Modern refrigerators and air-conditioners use hermetically-sealed compressor units with built-in motors. Therefore the only separate motors involved would be those used on any fan units involved.

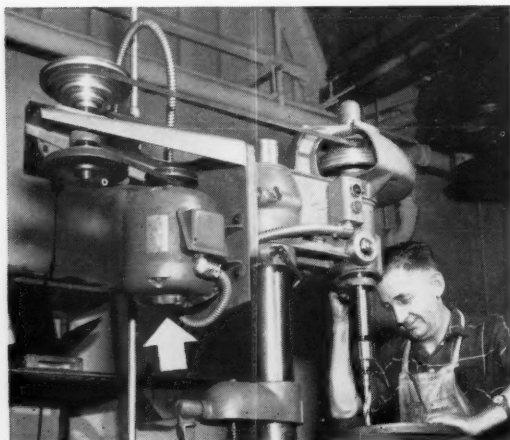
Home workshops: For home workshop equipment and miscellaneous applications, a group of motors called "utility motors" may be used. These are high-torque split-phase and capacitor-start motors designed like washing machine motors for a small number of total hours of operation. They may be continuous rated or intermittent rated. They are available in rigid base mounting and with sleeve or ball bearings, in various hp ratings at 1725 (4-pole) and 3450 RPM (2-pole) speeds.

Horsepower, speed, voltage, phase

Horsepower: Various methods have been proposed for determining the hp ratings required for different machines, including calculation, measurement of torques or tests with calibrated motors. In general, the only reliable method is that of testing with calibrated motors. While calculations of loading may be made for equipment such as pumps and fans, even these should be checked to confirm the values due to friction losses, entry losses or any other departures from ideal conditions.

In order to make tests with actual motors, it is first necessary to select a motor somewhat near the correct rating (from past experience) or perhaps to test several motors. It is possible to obtain special motors from the manufacturers which have been completely calibrated and curves drawn of the efficiency or input at different loads under various conditions or supply voltage and motor temperature. However, for most testing it is satisfactory to obtain a stock motor on which the manufacturers can supply a typical efficiency curve at rated voltage and average temperature.

The tests on samples of the apparatus are then made



6. Single spindle drill press with standard 1 hp motor.

using this motor, and the input voltage and watts are taken. It is important to use watts rather than amperes input because the current is far more sensitive to voltage variations, it varies more from one motor to another, and in many modern motors having higher magnetizing current it will not change appreciably with changes in load. From the watts input and the efficiency curve, the motor output or motor load may be determined. If the operating load is within the motor rating or service factor rating and the heat dissipation conditions are normal, then the motor temperature rise will be satisfactory. This can be checked if necessary by an actual heat run or temperature rise test.

It may also be necessary to check the starting operation, especially under low voltage conditions. This can be done if means are available to lower the voltage, and the minimum starting voltage can be noted. On apparatus with a varying load or special duty cycle it may be necessary to check the peak load and the RMS of the load. The motor manufacturers should be consulted regarding these tests, so that assurance may be obtained that the motor will operate satisfactorily under all the starting and running conditions of the equipment.

Speed: The most common speed for induction motors is the 4-pole 60 cycle speed, 1800 rpm synchronous and approximately 1725 or 1750 rpm full load speed. Two-pole motors of 3600 rpm synchronous speed are smaller, lighter and usually cheaper, but they are not used widely, except on direct-connected centrifugal pumps. The reason for their lack of popularity is the windage noise and the machine noise, machine vibration and drive complications at this speed.

Slower speed motors include 6-pole (1200 rpm), 8-pole (900 rpm) and occasionally still slower speeds. They are used on large equipment where the additional cost and size of the slow-speed motor is balanced by savings in the drive. They are also used on direct-connected fans to reduce the fan noise.

Voltage: Single-phase motors up to 1/3 hp are usually rated at 115 volts, from 1/3 to 1 hp at 115/230 volts and over 1 hp at 230 volts. The larger motors are designed to be connected with two circuits in parallel for 115 volts and in series for 230 volts. They should be connected whenever possible to 230 volts circuits in order to minimize the line drop, especially in starting.

The most common voltage rating for polyphase motors in this country is 550 volts, followed by 208 volts, 220 volts and 440 volts. For 208-volt network systems with good voltage regulation it is possible to use 220 volt motors for most applications, but the available starting and maximum torques will be reduced in accordance with the square of the reduction in voltage.

Phase: The choice of single-phase or 3-phase will be governed by the power supply available. In general, for ratings smaller than 1 hp the single phase motors will be cheaper because of the high volume of production. For ratings over 1 hp the 3-phase motors will be appreciably cheaper and will involve fewer problems of voltage drop in the power supply. Therefore they should be used in these sizes.

For specific requirements

We have dealt with some of the problems which face the design engineer in selecting and applying motors. For further information on specific cases you will find the motor manufacturer ready to work with you to provide the right motor for your application. ★

By B. F. Newman P. Eng.

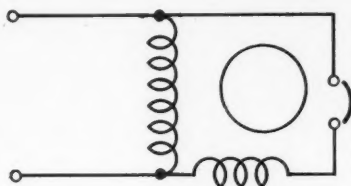
Design Engineering DATA SHEET

A guide to the common types of AC motors

SINGLE-PHASE MOTORS

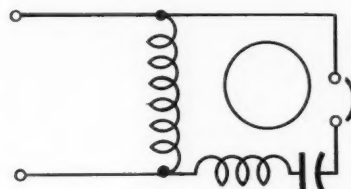
Characteristics

Split Phase



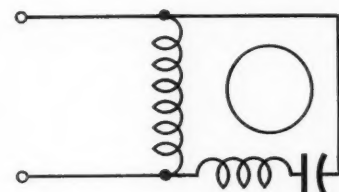
Starting winding has high resistance to give phase displacement. Intermittent starting duty. Low, medium or high torque. Up to $\frac{1}{3}$ hp.

Capacitor-Start



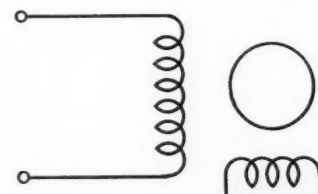
Starting capacitor added for higher starting torque and lower starting current. Heavy starting duty. General use: $\frac{1}{6}$ to 5 hp.

Permanent-split Capacitor



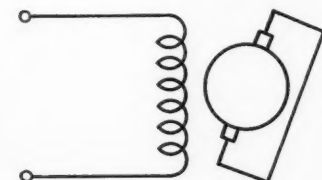
Continuous-rated oil-filled capacitor in auxiliary winding circuit. Low starting torque. Direct-connected fans: $\frac{1}{8}$ to 1 hp.

Shaded-Pole



"Shading" coils on pole tips. Low starting torque. Lower efficiency. Small fans: $\frac{1}{100}$ to $\frac{1}{20}$ hp.

Repulsion-Start



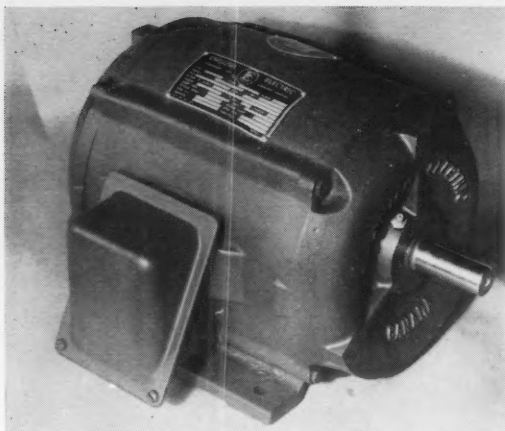
Starts as repulsion motor (similar to series motor) then commutator short-circuited for running. High starting torque. Heavy starting duty. General use: $\frac{1}{2}$ to 5 hp.

POLYPHASE MOTORS

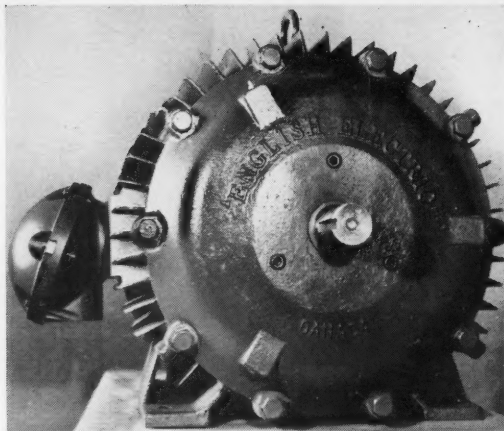
Polyphase squirrel-cage induction motor



Simple, rugged, efficient. Self-starting.



1. A 2-hp, 1,800 rpm drip-proof S.C.I. motor, 40C rise.



2. A 55C rise, explosion-proof 100 hp, 1,800 rpm motor.

Today's induction motors have new look

It's a far cry from the 1929 frame assignment standards, says expert

J. R. M. Szogyen, P.Eng.

Many of the most important details of performance characteristics and size of induction motors for general industrial use, that is, 1 to 125 HP, are set by mutual agreement by standardizing bodies such as C.S.A., A.S.A., C.E.M.A. and N.E.M.A. The manufacturers', as well as the users', points of view are represented in the standards set by these organizations. Under today's conditions of high motor production and intense competition, the motor designs must be planned to form part of a line of machines by selecting standard ratings, standard sizes and standard basic features that will simplify manufacture, reduce cost and provide for interchangeability.

The electrical industry of America was the first to set standard motor sizes and assign standard power ratings to these sizes. In 1926, at the request of machine tool builders and automobile manufacturers and others, a program was initiated by N.E.M.A. to establish size and output standards for industrial general purpose three phase squirrel cage induction motors. By 1929-1930 electric motor manufacturers started building motors to standard dimensions and ratings. This required the development by all motor manufacturers of completely new lines. This also required very large expenditures on design and tooling by the motor manufacturers with most of the direct benefits going to the users.

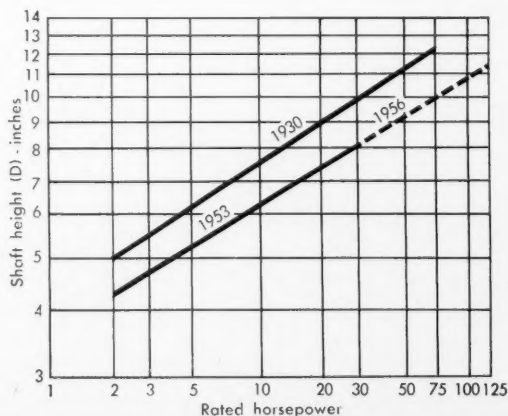
The standardization of sizes and ratings begins with the setting of standard mounting dimensions. The most important of these dimensional standards set the distance between the centre-line of the motor shaft and the base and also the axial distance between the centre of the motor and the shaft extension. For the most common practical case of symmetrical motors, these dimensions set by the standards limit the volumetric capacity of the standard motor size. One set of such standard mounting dimensions is often called a frame size. The frame size

number comprises three digits; the first two digits represent the four-fold shaft centre height in inches; the last digit is related to the length of the frame. The standard sizes were selected to provide the best coverage compatible with an economically small number of frames. They follow more or less closely a progression based on the 20th root of 10.

In the last few years, a number of European countries, among them England and France, have established similar standards, and the International Electrotechnical Commission is also working toward this goal.

Early changes in frame sizes

Technological advancement has been tremendous in the electric motor industry over the past 50 years. The industrial motor rated 5 HP at 1800 RPM weighed more than 200 pounds at the turn of the century; it now weighs little more than half of that. The increase in output obtained from a given frame is shown in the charts, Figures 3 and 5. This indicates the historically



3. Size reduction on open protected/dripproof motors.

Mr. Szogyen is in the Motor Engineering Division of English Electric Canada, St. Catharines, Ontario.

traditional trend of design progress. It is brought about by the continuing development of new and better materials, the unceasing demands of competition and great advancements in the art of design and manufacturing. It is the accepted plan to decrease periodically the motor sizes assigned to the standard output ratings from time to time as permitted by technical progress.

Changes in frame size since 1940

The frame assignment standards set in 1929 were revised in 1940, assigning higher outputs to the smallest three sizes and, in 1946, assigning higher outputs to the largest eight sizes. In 1953, the frame assignment standards were again revised, assigning higher outputs to the ten smallest frame sizes. This change was far greater than earlier ones for it covered a very much wider range, and it replaced four earlier standard sizes by new ones. The progression of frame sizes was made more rational and performance characteristics, such as locked rotor current, locked rotor torque, breakdown torque, overload capacity and temperature rise remained unchanged. Many of the new frame sizes have a suffix 'U' following the frame number which represents a shaft extension larger than that used before. This increase is necessary to transmit the higher outputs.

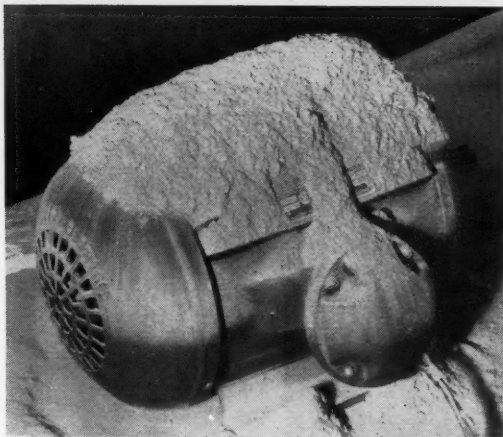
The main effect of this re-rating on the user, comes through the opportunity of obtaining about 50% more power out of the motor of certain size and resulting lower costs.

Design details accompanying the change

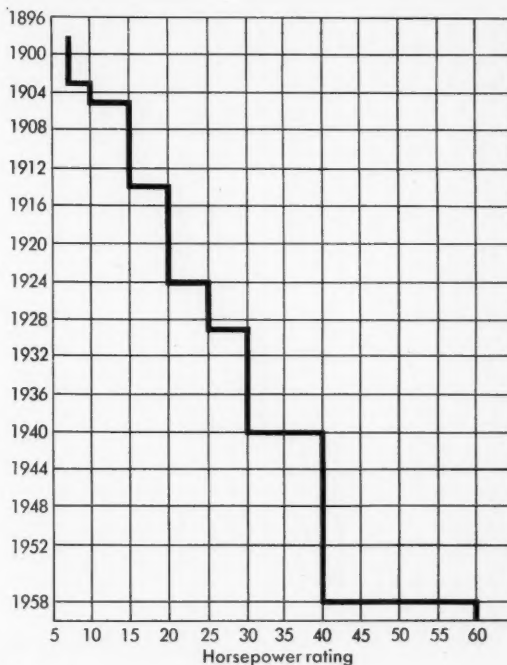
This re-rating is, in effect, a complete redesign. It calls for comprehensive fundamental engineering work and comprehensive new tooling also. With the change in frame assignment standards came a revision of the dripproof motor enclosure and an improvement of the protection offered against dripping or splashing liquids. The earlier motors were dripproof with a reasonable margin of protection over the minimum requirements of the standards. The new dripproof motor not only meets but surpasses these minimum requirements and offers a protection that is virtually splashproof. There are no ventilating openings on the stator frame; the ones in the endshield face downwards and subtend an angle no greater than about 100°. The absence of openings in the stator frame allows these motors to retain their virtually splashproof nature when mounted on a wall or ceiling, with the endshields rotated to face downward with their openings.

Figure 1 shows the appearance of the new dripproof motors. Figure 6 shows that, although the room required by the motor has decreased, particularly the room for the conduit box, the output of the motor increased from 3 to 5 hp at 1800 rpm. This picture also shows that the totally enclosed fan cooled explosion-proof motors were also completely redesigned. The cooling of these T.E.F.C. motors was changed from a double shell blow-through type to a single shell ribbed blow-over type. The main purpose of this change was to reduce the weight of the stator frame structure and to facilitate maintenance of the cooler. With the blow-through type, in extreme cases of dust contamination, it is conceivable to have the cooling ducts blocked without discovering this blocking before the motor overheats or burns out. On the blow-over type, the chance of blocking the cooling channel is less; also, if blocking occurs then, that is observed by anyone looking at the motor.

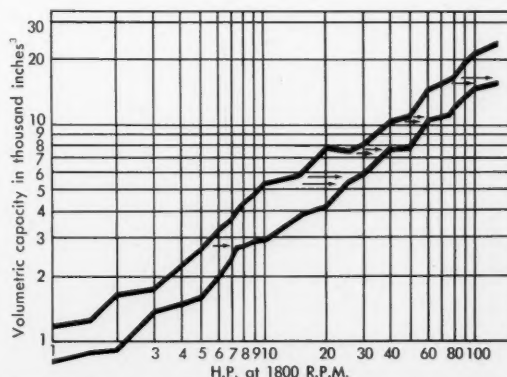
As part of the development work on these new motors, dust blanketing tests were performed. (see fig. 4). Grain dust was poured onto the stationary motor



4. Squirrel cage induction motor is dust tested.



5. Progressive output from given induction motor frame.



6. Volumetric capacity vs. hp rating of standard motors.

Induction motors *continued*

until no more dust would stay on; then the motor was started. It was found that after about five minutes' running all but about 7% of the effective cooling surface is free from dust. It was the advances in the understanding of the cooling systems that led the way, through numerous tests and exhaustive development work, to the more practicable, but admittedly less effective, single shell ribbed blow-over type on the smaller machines.

Related to these changes in the design of the cooling is the redistribution of the room available inside the standard frame size. The heart of the electric motor consists of two electrical circuits linked by a magnetic circuit. Between the electrical and magnetic circuits is a layer of insulation. The power output of a motor is proportional, for otherwise identical conditions, to the product of the electric current and magnetic flux. Increasing the power output of a certain volume of active material, that is, copper for the electric circuit and steel for the magnetic circuit, by 50%, can be attained by increasing the specific loadings in the electrical and magnetic circuits, that is, current and flux densities, by about 22.5% each.

No such great changes in the densities were or will be adopted because of retaining performance characteristics at the earlier established high levels. The 50% increase in power output of a certain frame size was and will be achieved, generally speaking, by: (a) about 15% to 25% increase in active material, partly at the expense of space taken by insulation and partly at the expense of space taken by cooling air passages; (b) about 5% to 10% increase in current densities; (c) about 18% to 14% increase in flux densities.

The new insulating materials used in the stator slots require very much less room, for identical insulation strength, than the earlier materials. The new designs of the cooling ducts require less room. These factors permit the increase in active material without change of frame size. Improvements in cooling and reduction in stray losses and improvements in the core steel and improvements in processing, when all combined, will permit the increases in densities suggested above. Figure 6 shows the great changes in the volumetric capacities of the motors, brought about by the changes in frame assignment standards. The graph on this drawing also shows that the 1956 re-rating is just a logical extension of the 1953 re-rating.

The increase in flux densities would not be possible

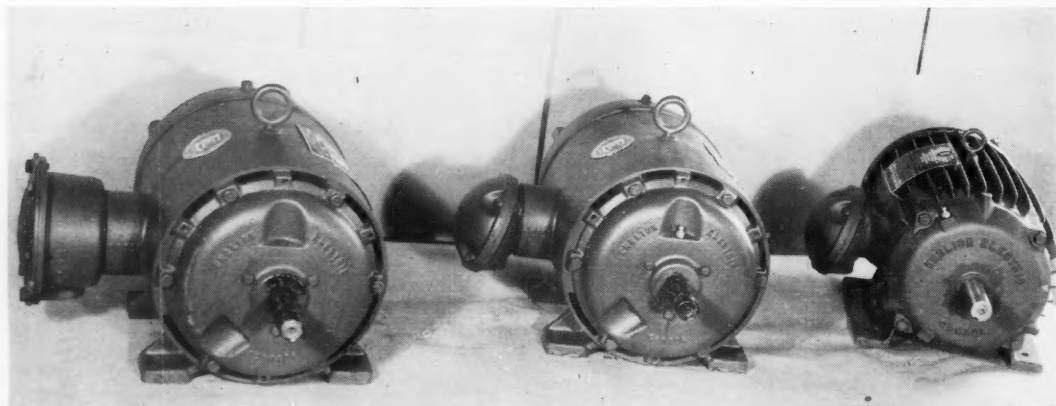
without the advances in the understanding of the nature and origin of harmonics and without the advances in the control of their ill-effects. Important development work was done on the effect of harmonics. A device was developed for the quick and easy indication of the torque developed by the induction motor. This device is now used for obtaining experimental proof of freedom from harmful and dangerous parasitic torques, on newly developed motors. Oscillograms show these parasitic torques of a faulty design. A number of new designs for the re-rated motors were rejected on type testing, on the basis of similar test results. These indications also revealed important information about stray load losses that caused considerable difficulties in keeping the temperature rise of the re-rated motors within the earlier set limits.

The increased flux densities make elimination of magnetic noises more difficult. Much work was spent on predicting and controlling noise. Factors that were unimportant at the lower flux densities have become limiting in some case. The case of our new 5 HP, 900 RPM motor will illustrate the kind of problems.

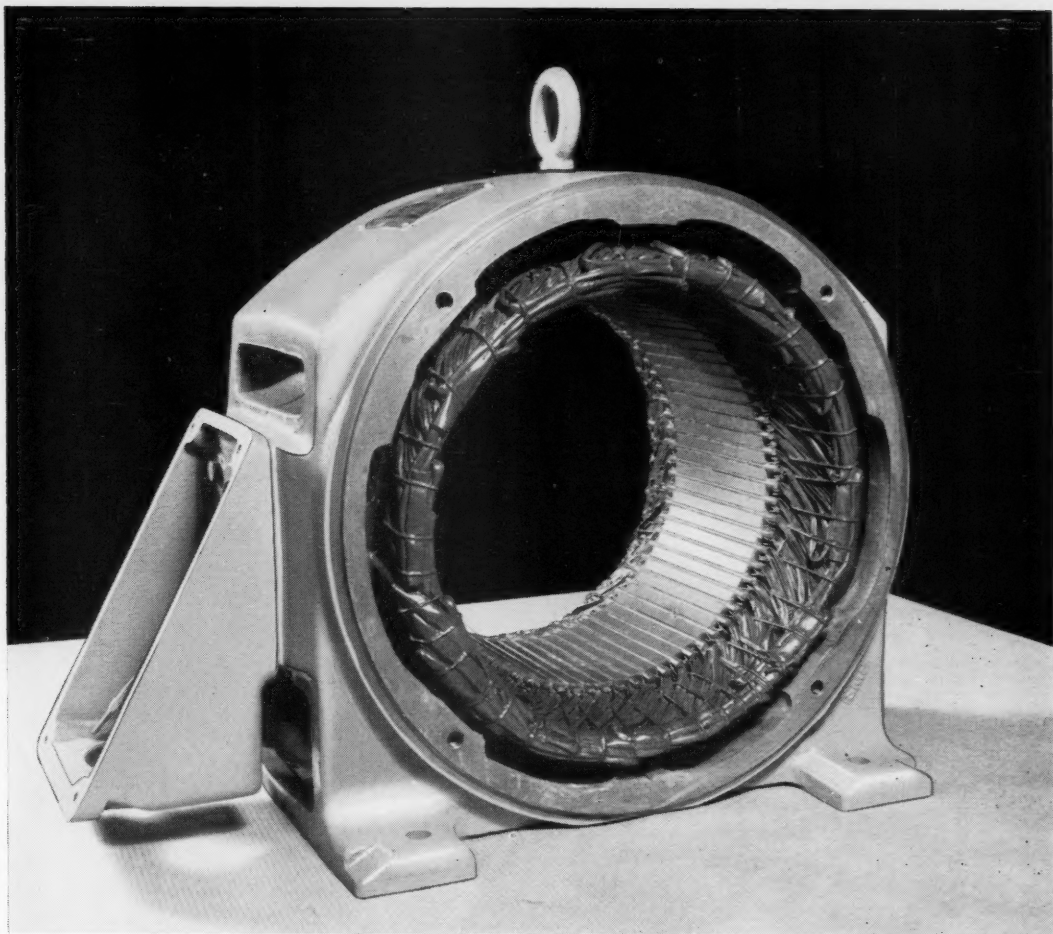
The stator and the rotor core laminations of the earlier size 254, 2 HP, 900 RPM motor were used on the first prototypes of both the dripproof open and T.E.F.C. new size 256U, 5 HP, 900 RPM motors. These prototypes also had the same skewing of the rotor slots as the well-proven earlier 2 HP motors. This proven combination of slots and skew was completely satisfactory for the new dripproof open motor in spite of the increased flux density, but was found to be unacceptably noisy in the T.E.F.C. enclosure. A comparison of the outside appearance of these motors shows that the T.E.F.C. enclosure is the stronger and more rigid one.

Figure 7 shows the appearance of this motor. One natural frequency of the T.E.F.C. stator frame happened to be close to one noise excitation frequency and this closeness did not occur with the dripproof frame. This relationship between frequency response characteristic of the stator frame and the noise excitation frequency became the limiting factor in this case.

In conclusion, standard sizes and frame assignments are used to simplify manufacture and to provide interchangeability. From time to time, as permitted by technical progress, the frame assignments are changed in a well organized and logical manner. These changes yield more power per unit space and weight and cost. Many difficult and interesting engineering problems have to be solved in connection with this re-rating. ★



7. Left, a 7 1/2 hp, 3,600 rpm unit; centre, 5 hp motor with new conduit box and right, a 7 1/2 hp, 3,600 rpm motor.



1. Motor insulation by the conventional varnish system. This method may be replaced by "fluidized" coating.

Electric motor insulation: what's new?

A summary of the latest developments and a hard look at the future

Raymond L. Bishop

Exclusive **DE** Feature

The answer to this question could be summed up in just two words — almost everything. In fact, it is possible to buy electric motors today in which every component of the insulation system has been developed during the past decade.

During this period, the chemical industry has been introducing new insulating materials faster than the electric motor industry has been able to properly evaluate them. The characteristics and properties of these new materials have necessitated the new concept of "integrated" insulation systems.

Mr. Bishop is insulation specialist in small motor engineering, Apparatus Dept., C.G.E., Peterborough, Ont.

First, let us discuss some of these new materials and then some of the "integrated" insulation systems utilizing these materials.

New insulating materials

Discussion in this article will be confined to just three groups of materials: polyesters, epoxies, and silicones. There are many other new materials such as polyurathanes, reconstituted mica products and irradiated polyethylene, but space does not permit a discussion on all these.

Polyesters

Polyester film, commonly known as "Mylar"* has had wide acceptance in the electric motor industry be-

cause of its amazing dielectric and mechanical properties. Some of the more important properties of this film in a .001 in. thickness are:

(1) dielectric strength—4,000 volts/mil (2) tensile strength—20,000 lbs./sq. in. (3) moisture absorption—less than 0.5% (4) excellent resistance to most chemicals.

It is being used in many ways in insulation systems. Thin gauges of it are used as tapes and wrappers on form wound coils. The heavy gauges are used as slot liners either alone or laminated to some other material. Some of the materials most commonly laminated to Mylar are rag or kraft paper, varnished glass and treated asbestos.

Polyester fibre is basically the same material as Mylar except that it is in fibre form rather than film. The fibres may be woven into a fabric or made up in mat form. The woven fabric is popularly known as Dacron.* When slit into tape, it is used on form wound coils.

Polyester wire enamel is commonly used in class B insulated motors at the present time. In some systems, it has been found acceptable for operation at class F temperatures.

Polyester impregnating varnishes and casting resins are also available, but as yet are used in a limited volume.

Epoxies

Epoxy wire coatings, impregnating varnishes, dipping compounds, and casting resins are all available at present. None of these materials have had wide acceptance in the electric motor industry to date. However, there is probably more development work going on with these materials than with any other group of materials. New formulations are becoming available at the rate of about one a week.

The impregnating varnishes and casting resins are the most commonly used epoxies today. Thixotropic epoxy dipping compounds will be used more extensively when formulations with a better balance of cured properties become available.

The excellent moisture and chemical resistance of the epoxies makes them desirable for use as a sealing or coating material. The main properties that must be considered when selecting epoxies are pot life, thermal stability, mechanical and thermal shock resistance, and chemical inertness.

Silicones

Silicone varnishes, rubbers, and compounds have been available for some years, but the past year or two has seen significant improvements, in all three types of silicone materials. The main advantages in using silicones is their ability to operate satisfactorily at 180 C and their excellent moisture resistance.

The main advance in silicone varnishes has been the development of varnishes that cure at lower temperatures and do not require step-curing to produce a blister or bubble-free finish.

The silicone rubber invented in 1942 had excellent dielectric strength and thermal endurance and could be vulcanized. However, it lacked the mechanical strength necessary to withstand the rigors of motor operation. The silicone rubber that is available today

has much improved mechanical strength without sacrificing dielectric or thermal properties.

Silicone rubber compounds, known as RTV (room temperature vulcanizing) compounds, are solventless pastes which cure up to tough silicone rubbers at room temperature after the addition of a curing agent. They have properties normally exhibited by heat cured silicone rubber, including excellent high temperature resistance. Cure times can be varied from a few minutes to two days by changing the type and concentration of catalyst. These compounds are available in several consistencies ranging from a fluid to a stiff paste.

New insulation systems

The insulation temperature classifications as covered in AIEE No. 1 were revised in 1957 so that insulation users could take advantage of (1) the improved properties and characteristics of the new insulating materials and (2) the concept of an "integrated" insulation system.

With the complex chemical composition of many of the new insulating materials appearing on the market, it is extremely important to remember that their optimum properties can be realized only by making them part of a well balanced and compatible insulation system.

The emphasis is on insulation systems now rather than on individual insulating materials. The reason for this new approach is that many of the materials now being used behave differently when in contact with different materials. For instance, vinyl tubings are not compatible with polyester wire enamel at class B temperatures in a sealed system. However, either material can be used successfully in separate systems.

In developing an insulation system there are four main criteria that must be considered: (1) voltage endurance (2) thermal endurance (3) mechanical endurance and (4) environmental endurance.

Most motor manufacturers have developed many insulation systems, each designed to meet the requirements of a particular application.

Encapsulated Motors

Discussion in this article will be confined to a special group of insulation systems that is attracting much attention at the present time: the completely sealed, random wound, insulation systems. There are at least six different systems available now. These are: (1) cast polyester (2) cast epoxy (3) silicone compound treated (4) epoxy paste applied to the end turns and stator bore (5) end turn treatment with a thixotropic epoxy resin (6) multiple treatments in epoxy varnish.

The wire insulation, slot liners, wedges, coil and phase separators, connection tubing and lashing, and cables for each of these systems must be carefully selected so that they are compatible with each other as well as the final sealing treatment.

The cast polyester system is not used extensively because of the expensive tooling necessary. The polyester resin however is much cheaper than epoxy or silicone rubber compound. Polyester encapsulation lends itself to a conveyor line process and is equal in mechanical strength and corrosion resistance to epoxy encapsulation.

The cast epoxy system has become quite popular during the past year or two, but many of the formula-

* Registered Trademark of Du Pont Company.



2. The thixotropic epoxy dip system will be used more.



3. Coming in for more attention is cast epoxy insulation.

tions used have serious deficiencies in the cured state. To use this system to advantage one must select the formulation that gives the best balance of properties, and then design around the weaknesses.

When added to a compatible insulation system, the improved silicone rubber compound now available makes a suitable protection for windings. Infused into the windings, the silicone compound provides an excellent seal against moisture, dusts, and other contaminants.

Epoxy paste or putty applied to the end turns and stator bore is the one system that requires no special tooling. When properly applied, this material protects the end turns as well as the cast systems, but it does not penetrate the slot sections of the windings.

Several thixotropic epoxy compounds are now available for coating end turns. When the windings are heated and dipped in this material, a coating from 1/16 to 1/8 in. thick can be obtained with one dip. As with the silicone rubber compound and epoxy paste, this material does not penetrate the slot sections.

Multiple treatments in epoxy varnish gives the thinnest coating of the systems described, but the degree of sealing is as good as any of the other systems. Being the same basic material, the chemical and moisture resistance of this system is also as good as any of the others. This system has the best thermal properties because of the relatively thin coating.

What of the future?

To this point we have discussed new insulating materials and new insulation systems. What does the future hold for electric motor insulation? Will there be as many changes during the next decade as there has been in the past 10 years?

We believe that during this period of time, we will see the demise of class A insulation systems. There will be increased use of class B and class H insulation systems. Class F, a classification added by the AIEE in 1957 and used very little to date will receive wide acceptance. It may even become the standard insulation class for some lines of motors.

The use of rag paper and film insulation for slot liners will probably be replaced gradually by a coating that will cover the ends of the core as well as the slot portion.

In many of the applications where varnish is now used as a coating on coils or winding end turns, it will no doubt be replaced by a coating applied by a "fluidized" or aerated bed method.

These are just a few of the changes that should take place in the field of electric motor insulation.

In the motor manufacturing industry and industries that use electric motors, insulation will continue to be a most interesting and pertinent subject. ★

Coming next month . . .

how good is your drawing office?

Tremendous advances have been made in the last few years in the function of the drawing office . . . new drafting machines . . . improved reproduction processes . . . precision mathematical instruments . . . new office layouts . . . improved drafting techniques . . . have you kept up to date?

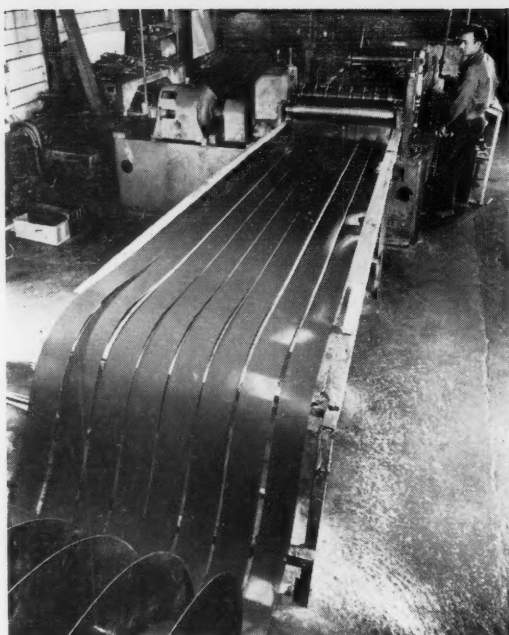
Read what the experts say in next month's

Design Engineering

Designews in Pictures



Battery filler is made of polyethylene plastic; valve fills batteries to correct level automatically — 300

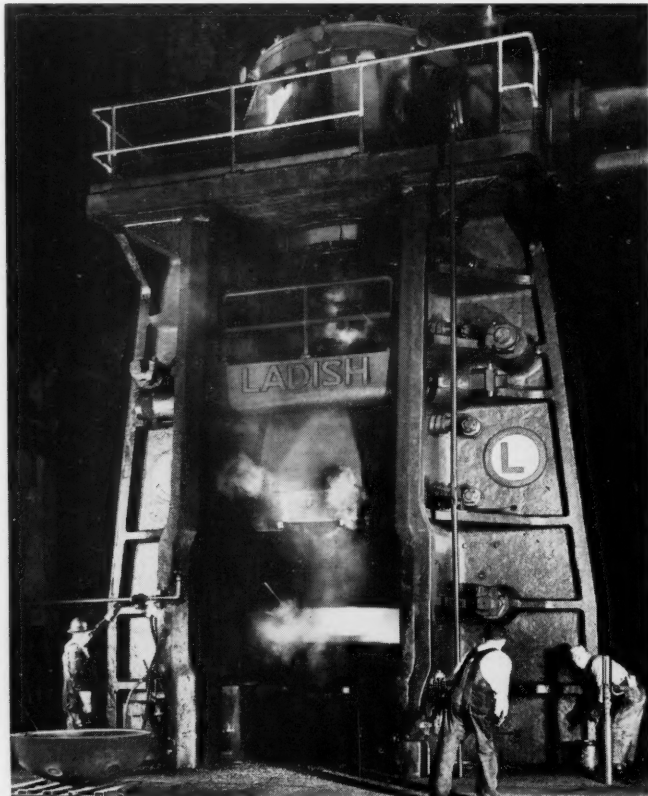


Coil of black, pre-enameled steel being slit into strips. Material comes in a wide variety of colors — 301

One man can move, erect, log this steel spar tree: it telescopes to 100 ft. — 302

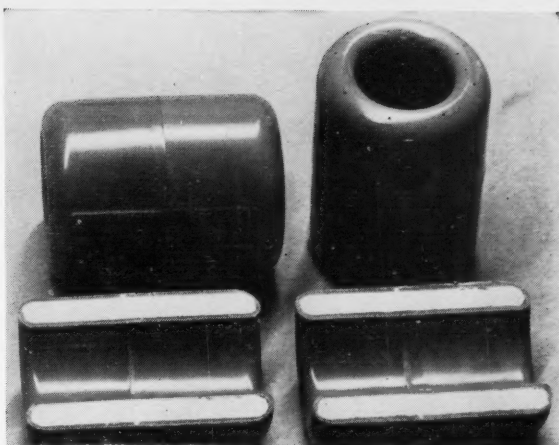


When this counterblow die forging hammer tackles job, more than 1,500,000 hp is released by a mass in motion of almost 500 tons—303





One-piece hose clamp design on this manometer cuts assembly cost 24 times—304

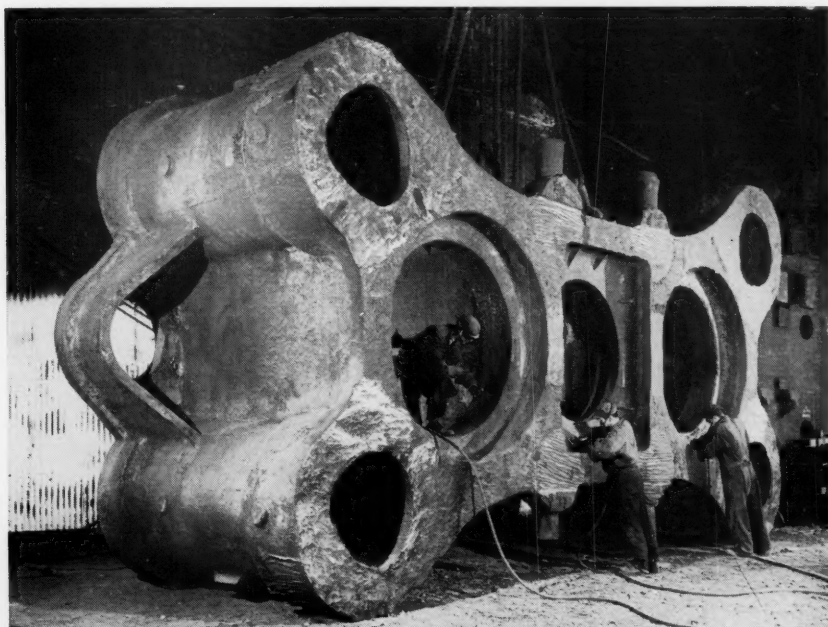


Cable floats are now being made in polyurethane foam—305



Special rubber sleeve insulator for rocket fuels — 306

This is a big casting in any language. Made in the UK, it measures 28 ft long, 14 ft high, 8 ft wide—and weighs 166 tons. Six furnaces were needed to produce the steel for this forging press component — 307



Design is always changing: the Caribou

Canadian aircraft wins new friends every week. It's a top example of constant creativity in design—brought new concept to transport planes

E. T. Burch

Lessons learned by hard experience are almost daily contributing to the development of today's products. Design engineers working in Canadian aircraft plants make constant reference to principles of aerodynamics based on facts learned in the early development of bush aircraft. Yesterday's bush pilot, flying with primitive instruments, had to rely on elementary knowledge of both mechanics and navigation. His aircraft was often made by hand in an abandoned warehouse by an enthusiastic veteran of World War I.

But the need for more and more aircraft gradually led to the development of regular airlines serving the north, and this in turn encouraged the development of a highly organized, distinctively Canadian aircraft industry.

In 1947, De Havilland of Canada brought out the DHC-2 Beaver, with a half-ton payload, followed in 1951 by the DHC-3 Otter, with an increased range and

1½-ton payload. Both enlarged on the capabilities of the earlier Canadian bush aircraft. But greater load-carrying capacity was needed, combined with longer range, and in 1958 the DHC-4 Caribou was test-flown, after a design and testing period of three years.

A new concept

The Caribou introduced to the world a new concept in transport aircraft. With a payload of 3½ tons, a landing speed of 62 miles per hour, a range of 1,450 miles, it will take-off after a ground run of only 530 ft, clearing a 50-ft obstacle in a total distance of 1,020 ft, with zero wind. As a comparison, regular airline technique requires a ground run of 990 ft, with a total run of 1,645 ft to clear a 50-ft obstacle at zero wind.

It will carry 30 passengers with 30 lb of baggage each, or 40 passengers with high-density seating. The military version will transport 24 fully equipped ground troops.

Of high-wing cantilever design with full-span slotted flaps and ample tail area, power is supplied by two Pratt and Whitney R-2000-7M2 engines rated at 1,450 bhp (take-off), driving full-feathering Hamilton Standard propellers. Its Short Take-off and Landing (STOL) characteristics, the steep approach, wide-angle cockpit

The work of the Canadian design engineer is continuously changing the shape of our daily living. Good design is never stagnant—and the leaders are always seeking to improve their designs. Design Engineering is planning a series of articles to examine some typical products designed and produced in Canada. This profile of the distinctive and unique Caribou is the first in this series.

For years de Havilland of Canada has built a world-wide reputation in 60 countries on seven continents, with the DHC-2 Beaver and the DHC-3 Otter proving their worth from the tropics to the poles.

But a higher capacity aircraft was required, and in 1958 the DHC-4 Caribou was test-flown, after three years of intensive design studies, prototype construction and experimental development. It gave the world the first aircraft in its weight category designed primarily for Short field Take-off and Landing (STOL).



1. D. H. 84 Dragon carried mail for Canadian Airways between Moncton and Charlottetown for ten years.

visibility, and excellent control at low approach speeds enable the pilot to precision-pick the point on the strip for a touchdown. Ultra short landing roll, coupled with long-stroke, rugged landing gear of special design give the Caribou the added qualities needed for remote-terrain operation.

Climb gradient with landing gear up is 16.5%; its descent gradient 15.0%. These STOL characteristics enable the Caribou to operate from short fields close to large cities previously accessible only to light aircraft.

Functional and streamlined

The Caribou's functional lines give her a truly streamlined look. Unlike her predecessors, the Beaver and the Otter, which look like the tough workhorses they are, the Caribou has a graceful, airline look about her. The polished aluminum fuselage, the upswept tail assembly, and the high cantilever wing make her look flashy and modern in the air. On the ground, with a 3-ton truck backed up to her ample rear door, unloading bulky freight into her 1,150-cu-ft cabin, she proves her sturdy efficiency.

The wide rear cargo door, adjustable ramp, and other loading features contribute successfully to the Caribou's quick turn-around time—an important feature for both airline operation and military use. In a demonstration, over 6,000 lb of cargo were off-loaded and a similar volume of freight loaded in a total turn-around time of 5 minutes.

The design team

The team responsible for the design, development and production of the Caribou are:

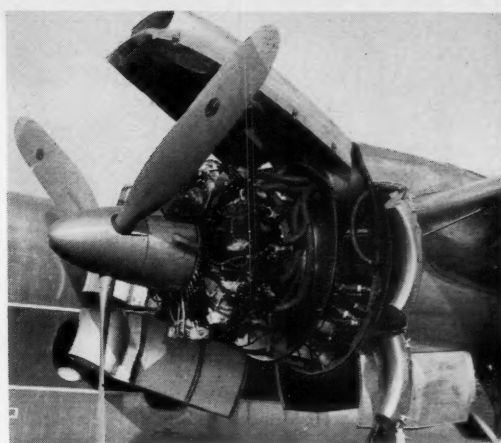
Engineering Director W. D. Hunter, F.A.I.C., P.Eng., has worked on aircraft design since 1913. His work has included the Airship R-80; the Vigilant Flying Boat; Fairey Aircraft; the DH-66; DH-60X Moth; DH-61; DH-65; Tiger Moth; Puss Moth; Dragon; Dragonfly; Rapide; DH-86; and Mosquito. Since joining DH Canada, he has been responsible for the design, development and production of the Fox Moth; Chipmunk; Beaver; Otter; and Caribou.

Assistant Chief Engineer R. D. Hiscocks, M.B.E., B.A.Sc.; M.A.I.S., F.A.I.C., M.E.I.C., has worked with DH since 1946, contributing to the design and development of the Chipmunk, Beaver, Otter, and Caribou. First winner of the McCurdy Award for design work, he worked previously with the National Research Council studying vibration in aircraft and on the design of the molded-plywood Harvard. He was also Project Engineer on NRC's Tailless Glider project.

Chief Design Engineer F. H. Buller, F.C.A.I., has worked with DH since 1944; has collaborated in directing engineering design and development on the Chipmunk, Beaver, Otter, and Caribou.

Acclaimed by world

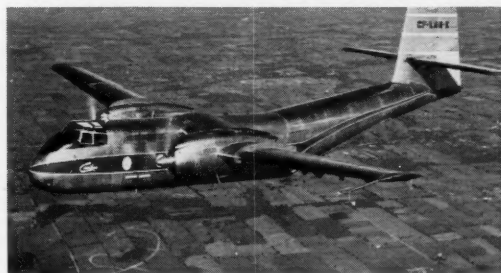
The world has hailed this new concept in transport aircraft. Characterized by an unprecedented ability to manoeuvre a large (3½-ton) work-load into short, unimproved landing strips in remote undeveloped terrain where airports are unknown and maintenance facilities elementary, the Caribou has fulfilled its design concept so well it has been selected for intensive testing by both the American and Canadian armed forces. ★



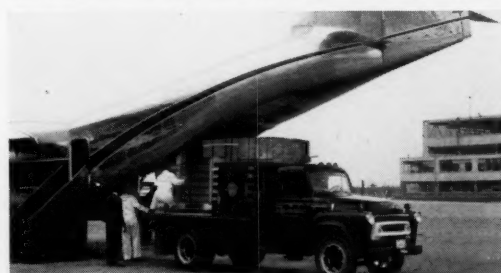
2. The petal-type cowlings make engines easily accessible for basic maintenance and servicing in remote areas.



3. Pilot has 260 deg forward vision in plexiglass enclosed cockpit. P and W engines each produce 1,450 hp.



4. In-flight photograph shows clean, functional lines of the Caribou. It can take-off after mere 530 ft run.



5. Rear doors give easy access to the 1150 cu. ft. cabin.

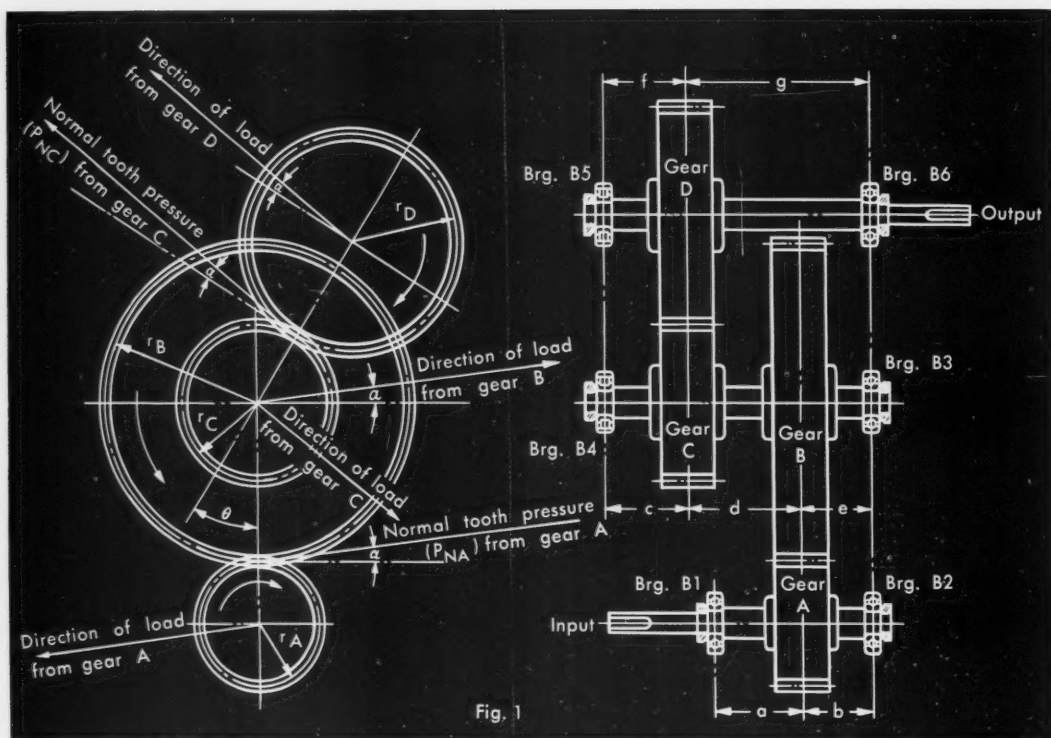


Fig. 1

Hints on calculation of bearing loads

Trouble-free service throughout a bearing's life usually begins at an early design stage. These calculations will help you assess the load

Bearings form an unseen but vital factor in the successful functioning of any mechanism. Careful attention to detail at an early design stage will ensure trouble-free service throughout its life.

The calculations involved are fairly elementary and are worked out from the known input horsepower at a given speed. However, in many mechanisms the designer's skill and experience are needed to determine the basic requirements from which the loads can be calculated and a suitable bearing selected for the job.

This article was condensed from "Design for Bearings" as published by R&M Bearings Canada Ltd., Montreal.

Before selecting a ball or roller bearing for a particular application, it is necessary to determine the magnitude of the load which will be imposed on the bearing and the speed at which it will be required to operate. To simplify the calculations used in this article an efficiency of 100% has been assumed throughout.

Origin of bearing loads

Torque. Reactions produced by torque in power transmissions such as in gear, belt or rope drives.

Tension. Tension required in order to transmit the power in belt and rope drives.

Miscellaneous loads. Due to centrifugal force, out-of-balance and inertia loads.

Weight. Weight of machine parts supported by bearings, such as shafts, gears, pulleys and fly-

wheels. In the majority of applications the shaft weight is negligible when compared with the torque reactions and may be ignored.

Nature of loads

Loads may be either radial or thrust (acting parallel to the shaft) or may be a combination of the two. Thrust loads are also known as location or axial loads.

Journal load (J). This is the load applied at right angles to the axis of the shaft and may be due to tangential or separating forces in gearing, to some other form of transmission, or to the weight of the machine parts.

Thrust load (T). Due to worm, helical or bevel gear drives or any forces acting parallel to the axis of the shaft and bearing.

Very often there will be a combination of several journal loads acting simultaneously. In this case it is necessary to resolve the loads on one bearing only. The simplest method is to use a polygon of forces.

Fig. 2a shows a number of journal loads acting on one bearing. The resultant load is obtained by drawing the force diagram shown in Fig. 2b with each load line set out to a scale proportionate to the actual load and in the direction in which it operates. Each force is taken in turn so that in the force diagram the directions, shown by arrows, follow one another. When all forces have been considered, then the line necessary to close the diagram, when scaled, gives the magnitude of the resultant load. Its direction is that at which the resultant load operates.

Distribution of loads

Two conditions are possible with a shaft supported on two bearings:

- (1) The load "L" may be imposed between the two bearings as in Fig. 3a.
- (2) The load may be overhung and applied outside the bearing centres as in Fig. 3b.

For Fig. 3a:

$$\text{Load on bearing B1} = L \times \frac{b}{c} \text{ lb.}$$

TABLE 1. TENSION FACTOR "F"

Belt drives (average)
factor = 3; Load on belt pulley = 3P
Belt drives (very tight)
factor = 4; Load on belt pulley = 4P
Rope drives (average)
factor = 2; Load on rope pulley = 2P
Rope drives (very tight)
factor = 3; Load on rope pulley = 3P
V rope drives
factor = 1.5; Load on rope pulley = 1.5P
Chain drives
factor = 1.0; Load on chain pulley = 1.0P

$$\text{Load on bearing B2} = L \times \frac{a}{c} \text{ lb.}$$

For Fig. 3b:

$$\text{Load on bearing B3} = L \times \frac{b}{a} \text{ lb.}$$

$$\text{Load on bearing B4} = L \times \frac{c}{a} \text{ lb.}$$

EXAMPLE: (Fig. 3a.) Let $a = 5''$; $b = 10''$; $c = 15''$ and radial load (L) = 990 lb.

$$\text{Load on brg B1} = 990 \times \frac{10}{15} = 660 \text{ lb.}$$

$$\text{Load on brg B2} = 990 \times \frac{5}{15} = 330 \text{ lb.}$$

Torque produced by input horsepower

Torque is the product of a tangential force and a radius at which the force acts; it is usually expressed in lb. in. (Tangential force being in pounds and the radius in inches.)

When P = Tangential force at circumference of driving member.

Q = Torque in lb. in.

Hp = Horsepower transmitted.

N = Revolutions per minute.

r = Radius of driving member in in.

Work done by force P at radius r and N revs. per min. = $W = P \times 2\pi r N = 2\pi Q N$ in. lb./min.

$$\text{The input Hp} = \frac{2\pi Q N}{396,000} \text{ (where 1 Hp} = 396,000$$

in. lb. of work per minute).

Therefore

$$Q = \frac{396,000 \times \text{Hp}}{2\pi N} = \frac{63,025 \times \text{Hp}}{N} \text{ lb. in.}$$

$$\text{or } P = \frac{63,025 \times \text{Hp}}{N \times r} \text{ lb.}$$

Belt, rope and chain drives

The total radial load imposed on the bearings is due to the tangential driving force. This is the pull on the tight side of the belt, rope or chain together with the tension factor as given in Table X. With short centre or large ratio belt drives, a tighter belt is required and provision should be made for this when selecting the desired factor.

$$\text{Tangential driving force } P = \frac{63,025 \times \text{Hp}}{N \times r} \text{ lb.}$$

Where Hp = Horsepower transmitted.

N = revolutions per minute.

r = radius of pulley of chain gear in inches.

For Fig. 4a:

$$\text{Load on bearing B1} = P \times F \times \frac{b}{c} \text{ lb.}$$

$$\text{Load on bearing B2} = P \times F \times \frac{a}{c} \text{ lb.}$$

continued

For Fig. 4b:

$$\text{Load on bearing B3} = P \times F \times \frac{b}{a} \text{ lb.}$$

$$\text{Load on bearing B4} = P \times F \times \frac{c}{a} \text{ lb.}$$

Straight spur gears

When two straight gear teeth mesh, two forces are produced, namely tangential and separating forces. These can be resolved into one resultant component. This resultant represents the load imposed on the shaft. Apart from the effect of inaccurate teeth, pure radial loading only is produced. The analysis of these forces is shown diagrammatically in Fig. .6

$$\text{Normal tooth pressure} = \frac{\text{Tangential force}}{\cos \alpha}$$

Where α = Tooth pressure angle

$$\text{Tangential force } (P_T) \text{ in. lb.} = \frac{63,025 \times \text{Hp}}{N \times r}$$

Where Hp = horsepower transmitted; N = revs. per min; r = pitch radius of gear in inches.

Then from the above, the normal tooth pressure

$$(P_N) \text{ in. lb.} = \frac{63,025 \times \text{Hp}}{N \times r \times \cos a}$$

Bearing loads (see Fig. 6):

$$\text{Load on bearing B1} = P_N \times \frac{b}{(a + b)} \text{ lb.}$$

$$\text{Load on bearing B2} = P_N \times \frac{a}{(a + b)} \text{ lb.}$$

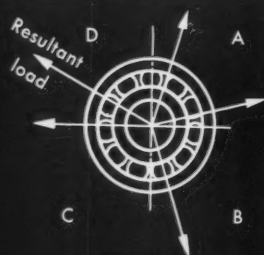


Fig. 2a

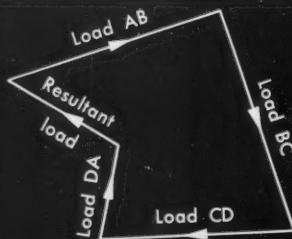


Fig. 2b

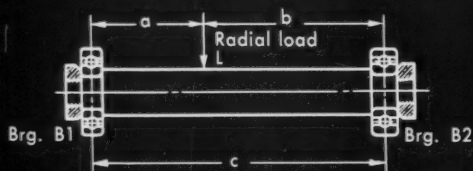


Fig. 3a

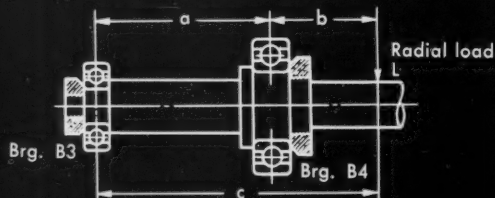


Fig. 3b

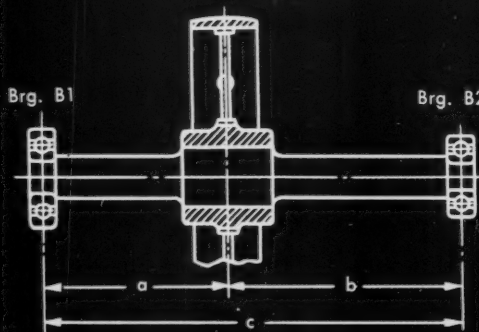


Fig. 4a

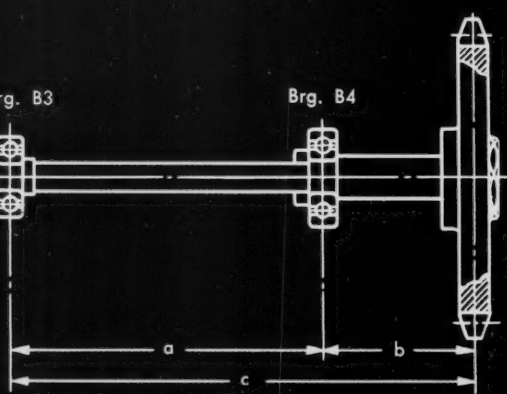


Fig. 4b

$$\text{Load on bearing B3} = P_N \times \frac{d}{(c + d)} \text{ lb.}$$

$$\text{Load on bearing B4} = P_N \times \frac{c}{(c + d)} \text{ lb.}$$

EXAMPLE: (Fig. 8). Single reduction spur gears transmitting 40 hp at 800 rpm. Pitch circle diam. of driving pinion = 12"; tooth pressure angle = $14\frac{1}{2}^\circ$; spacings are as shown.

Normal tooth

$$\text{pressure } (P_N) = \frac{63025 \times 40}{800 \times 6 \times .9681} = 542 \text{ lb}$$

$$\text{Load on brg. B1} = 542 \times \frac{12}{(8 + 12)} = 325 \text{ lb}$$

$$\text{Load on brg. B2} = 542 \times \frac{8}{(8 + 12)} = 217 \text{ lb}$$

$$\text{Load on brg. B3} = 542 \times \frac{20}{(8 + 20)} = 387 \text{ lb}$$

$$\text{Load on brg. B4} = 542 \times \frac{8}{(8 + 20)} = 155 \text{ lb}$$

Spur gear train

In a train of gears there is often more than one gear mounted on each shaft. To determine the

resultant load on the bearings, it is necessary to calculate each gear load separately and then solve graphically by means of a "polygon of forces." See F.1

r_A = pitch radius of gear "A" in inches.

r_B = pitch radius of gear "B" in inches.

r_C = pitch radius of gear "C" in inches.

r_D = pitch radius of gear "D" in inches.

α = Tooth pressure angle.

θ = Plane angle of gears.

Hp = Horsepower transmitted.

N = revolutions per minute of Gear "A".

Normal tooth pressure from gear

$$\text{"A"} = P_{NA} = \frac{63,025 \times \text{Hp}}{N \times r_A \times \cos \alpha} \text{ lb.}$$

Normal tooth pressure from gear

$$\text{"C"} = P_{NC} = P_{NA} \times \frac{r_B}{r_C} \text{ lb.}$$

Bearing loads:

$$\text{Load on bearing B1} = P_{NA} \times \frac{b}{a + b} \text{ lb.}$$

$$\text{Load on bearing B2} = P_{NA} \times \frac{a}{a + b} \text{ lb.}$$

$$\text{Load on bearing B5} = P_{NC} \times \frac{g}{f + g} \text{ lb.}$$

$$\text{Load on bearing B6} = P_{NC} \times \frac{f}{f + g} \text{ lb.}$$

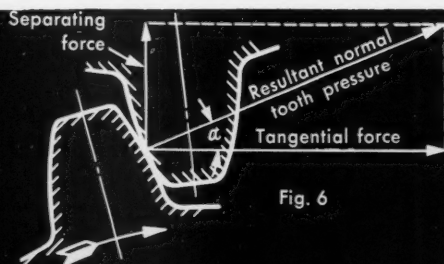


Fig. 6

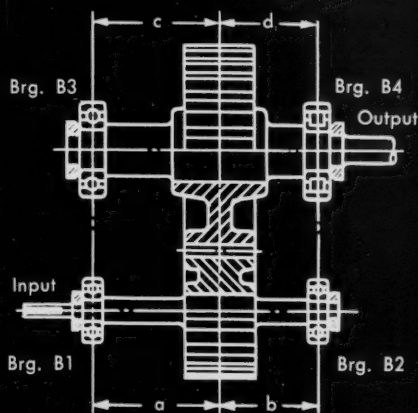


Fig. 7

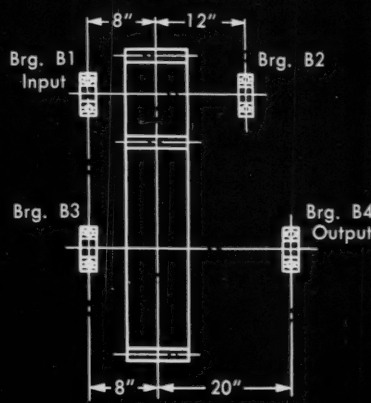
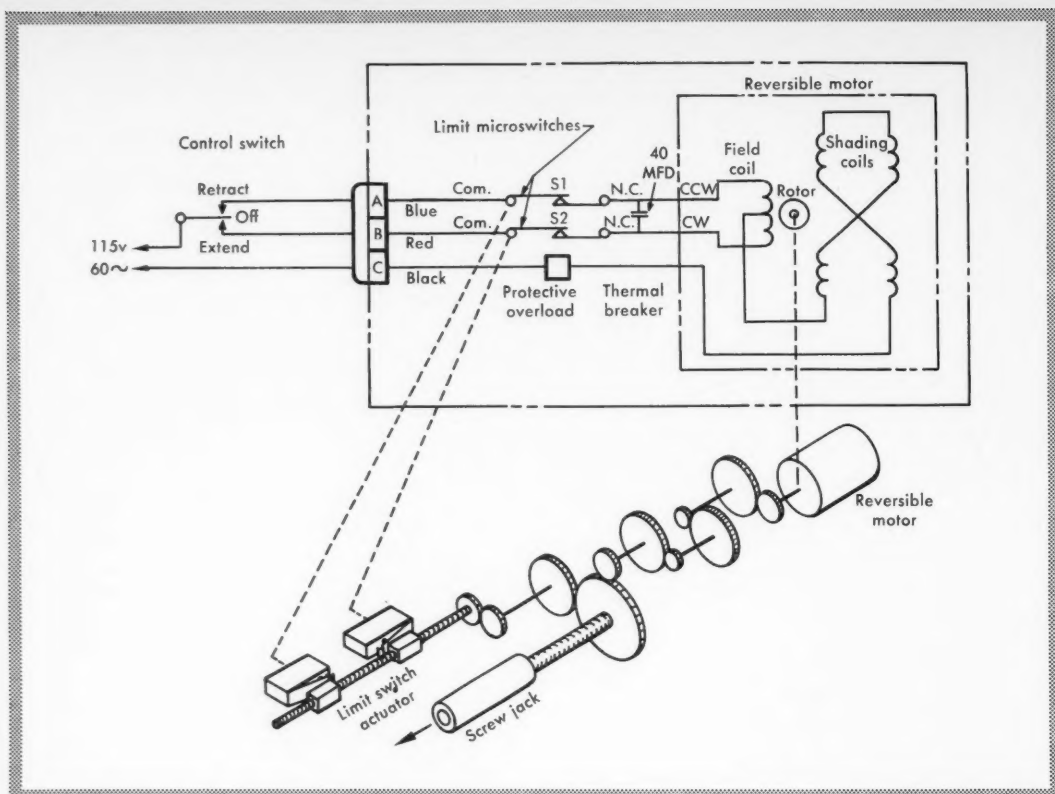


Fig. 8



1. The electrical and mechanical schematic layout of the actuator. Four-stage reduction gear train is featured.

Seaway is test for underwater actuator

Aircraft experience is invaluable in making parts for water turbines

L. S. Eggleton

Exclusive **DE** Feature

The designer of electrical equipment for the modern aircraft is accustomed to being faced with tough conditions under which his equipment must operate. Temperature ranges can be from +160 F to -65 F with high acceleration forces, while the fiendish "torture" tests called up by MIL and other specifications can be relied upon to tax his ingenuity to the utmost.

Tests in hot and cold chambers, high humidity, powerful vibration, salt sprays, are factors which the aircraft equipment designer is accustomed to overcoming. Probably the only requirement which he had not had to provide was for his design to operate under water.

Yet this was the requirement that was recently placed before the engineering department at Aviation Electric Limited. Specifically, there existed a need for an electrical actuator to provide remote control of a pair of latches 90 feet below the surface of the water. These latches form part of the water control system for

the turbines of the St. Lawrence power project. They are required to operate near the bottom of the 90 ft. deep head pond shown in the upper right of the picture of the powerdam (fig. 3).

A search of the market by the Ontario Hydro Commission had failed to find a standard commercial item "off the shelf" to meet the conditions.

It was considered, therefore, that the best people to design an item like this would be a company who knew how to make a unit which would withstand rugged conditions, yet be able to pack a great deal of power in a small space. Designers of aviation equipment live with these factors every day and in this case they would not be confronted by their old bugbear of weight, usually the most important factor in their designs.

At about this same time there had been completed the design of a highly compact ac-dc electrical actuator for the Royal Canadian Navy which would form part of the Bendix PB20F autopilot system in the Navy CS2F Tracker aircraft. The experience and know-how gained in the Navy project was therefore available for application to this underwater actuator.

Mr. Eggleton, author of this article, is in charge of technical publications for Aviation Electric Ltd., Montreal.

Design parameters

The design parameters set down were as follows:

- (1) The actuator must be completely water-proofed for, as already mentioned, it has to operate under 90 feet of water. The pressure at this depth is of the order of 50 pounds per square inch. This requirement meant that particular attention would have to be paid to general waterproofing at the points where the various housings would fit together. Also to be waterproofed were the connector where the standard 115-volt 60-cycle electricity supply entered and the seal where the mechanical output of the ram of the actuator passed through the housing.
- (2) The 115-volt 60-cycle electric motor must be reversible and fitted with limit switches which would allow the ram to have a stroke of six inches, to be accomplished in one minute. Power output of the ram had to be about 500 pounds.
- (3) Material specifications permitted whatever material was best suited to the job, irrespective of weight. The minimum operating temperature was -30°F and the size was restricted physically to a maximum width of nine inches.

Design procedure

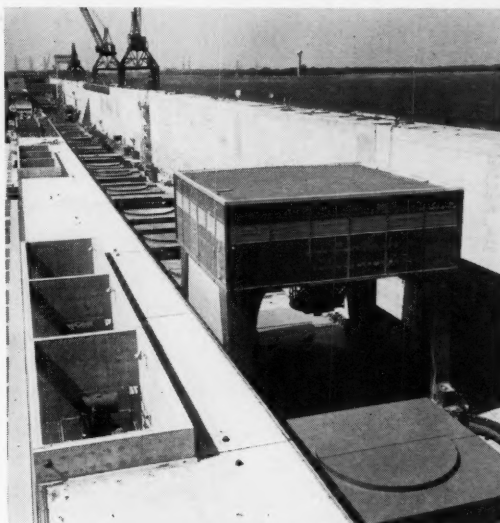
The electric motor, being the heart of the device, was first considered. To keep the cost as low as possible, we looked about for a standard type and eventually our choice fell on the Barber-Colman Type CYAE 4727. This unit is a 115-volt 60-cycle shaded pole motor having two sets of shading coils to give reversing action. The use of the centre-tapped field coil together with the

40 mfd capacitor more than doubles the torque output over the standard circuit.

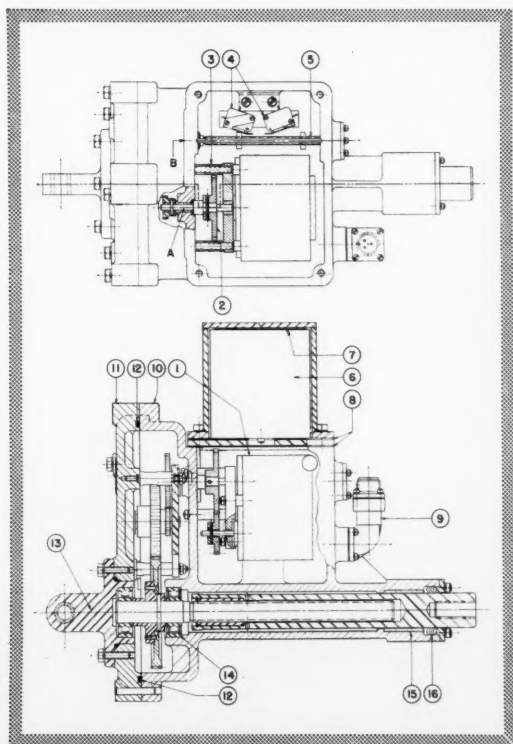
Figure 1 shows the electrical and mechanical schematic layout of the actuator.

A four-stage reduction gear train with an over-all ratio of 3:128 couples the motor to the screw jack with a net power gain of approximately 24:1. The screw jack in turn, as it converts from rotary to linear motion, further boosts the power output from the gear train up to about 500 pounds.

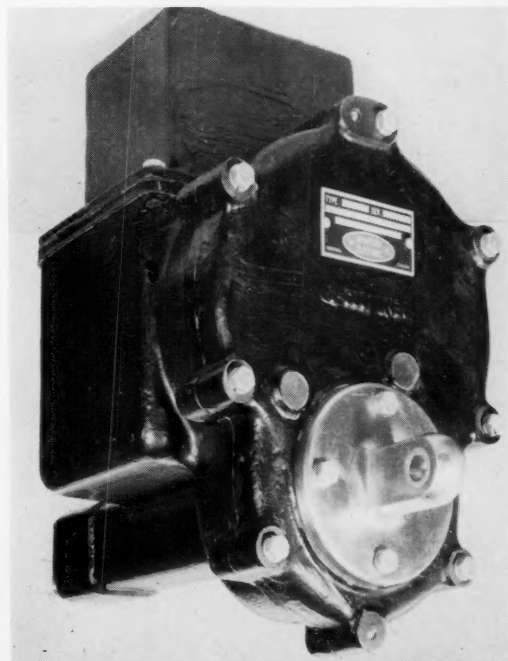
A secondary gear train engages with the output gear of the main train and provides a suitable reduction ratio to drive the lead screw of the limit switch actuator. This



3. Actuators operate a pair of latches helping to control 90 ft deep head pond in St. Lawrence Seaway powerdam.



2. Cross section shows how components are arranged inside body; emphasizes parts making it water-tight unit.



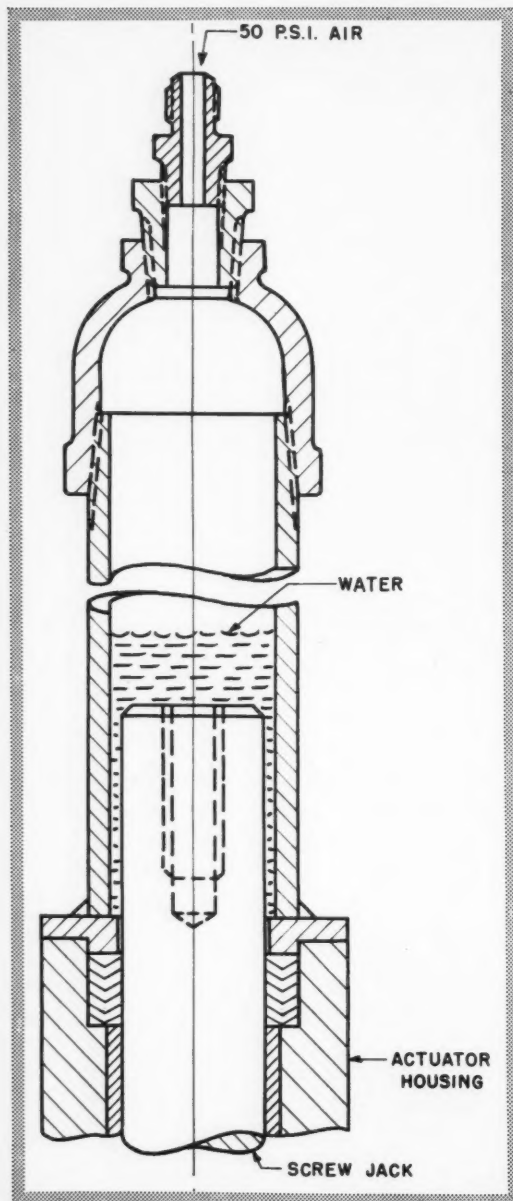
4. Overall design prevents entrance of water while allowing ram free movement — an essential need of the unit.

Underwater actuator *continued*

lead screw, as it turns, causes two nylon nuts to slide longitudinally so that their surfaces act as operating cams for the limit switches. These two switches control the extent of travel of the ram of the screw jack, and the positions of the nylon nuts can be adjusted to give the desired stroke of six inches.

Arrangement of parts

The cross section (fig. 2) shows how these components are arranged inside the body and also emphasizes the various features which make this actuator a truly water-tight unit. All parts of the body are made



5. How the adaptor is fitted over the ram of the actuator used in testing the unit. Note air pressure application.

from cast iron.

The reversible motor (1) is housed in the inner chamber of the actuator, together with the first stage of the gear train (2). This first stage is mounted on the motor and forms a compact little sub-assembly which is itself secured to the wall of the inner chamber by four pillars (3). This chamber also contains the limit switches (4) and their operating mechanism (5), together with a protective thermal overload breaker.

The 40 microfarad starting condenser (6) for the motor has its own separate housing (7) which forms a lid for the inner chamber. As the terminals of the condenser project down into the inner chamber this means that all electrical wiring is contained inside this chamber. Neoprene gaskets (8) with Pliobond cement provide a watertight seal. Power from the 115-volt 60-cycle control circuits is fed into the motor through a special watertight connector (9) supplied by the Scintilla Division of the Bendix Aviation Corporation.

Mechanical output from the first stage of the gear train is passed through the wall of the inner chamber at point A, while the drive for the limit switch mechanism enters at point B. Both these shafts run in Oilite bronze bearings which means that, with all other possible entrances sealed, the inner chamber is also virtually sealed should water ever enter the outer gear train housing.

This outer housing is in three pieces. The piece (10) is part of the main body casting while the piece (11) carries the remainder of the gear-train, each stage having a set of bronze Oilite bearings. Note the groove which is machined all around the periphery. This groove carries an AN "O" ring (12) which, together with the precisely machined faces of the two castings, ensures a watertight seal. Part (13) provides a combination external mounting lug and internal retainer for the outer ball bearing of the screw jack. Another AN "O" ring prevents water entering between the flange of part (13) and the surface of part (11).

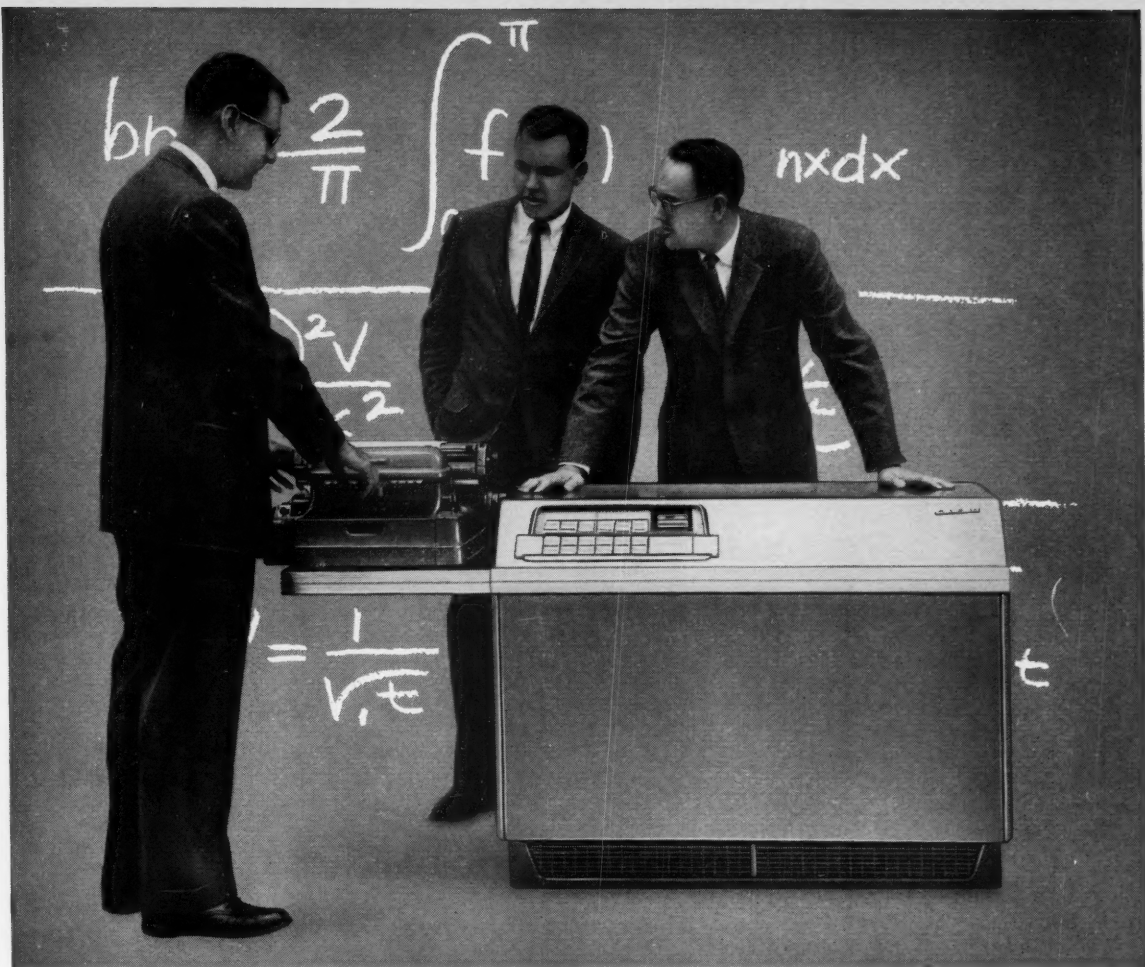
The remainder of the screw jack is supported by a second ball bearing (14) and by a 1½ in. long bronze Oilite bearing (15) at its other end. The ball bearing (14) has double shields which would prevent water from entering the gear train housing even if water were to get into the screw jack compartment. As a means of preventing such an occurrence, the ram of the jack passes through a series of Teflon packing rings which, held in place by a retaining plate and screws, effectively exclude water while allowing the ram free lateral movement.

Design was tested

After the design was completed the prototype unit was subjected to various qualification tests for which we either built or adapted our own test equipment.

Power output was checked using the test facility already installed in the actuator section of the electrical overhaul shop, but in order to test for leakage, the hydraulic laboratory devised a simple, but effective adapter.

Figure 5 shows how this adapter is fitted over the ram of the actuator. The four screws securing the plate retaining the Teflon packing rings are removed and reinserted through the holes in the flange of the adapter. Sufficient water to cover the end of the ram is introduced into the adapter and 50 psi of air is applied to the fitting in the end of the adapter. The actuator was then cycled for several hours with the pressure applied. The actuator was then dismantled and checked for leakage. Everything was as dry as a bone. ★



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Every manufacturer knows that in order to make sales he has to get his product to the right market.

If he can bring the market to the product, so much the better. That's the reasoning behind the "What's New in Manitoba" exhibit staged each year by the province's industry and commerce department, held in conjunction with Winnipeg's Red River Exhibition and Brandon's Provincial Exhibition.

Through these shows Manitoba's manufacturers are given the opportunity of displaying their new products directly to thousands of consumers. Total attendance at the two fairs was nearly 300,000.

More than 80 newly made products—representing 54 Manitoba firms—were displayed. They ranged from food and clothing to plastic items, sporting equipment, trailers, luggage carrier, archery supplies, lighting equipment and automotive accessories.

The "What's New" exhibit showed what Manitoba manufacturers had accomplished in the way of new designs and applications—and indicated the extent of Manitoba's industrial growth and diversification.

Manitoba firms who are leading the way in new-product development are recognized by "merit awards" from the industry and commerce department. A panel of judges chooses the winners.

The accompanying photographs illustrate winning products which were designed and developed by Manitoba design engineers.

1. Controlite Street Lighting Relay—by Pioneer Electric Brandon Ltd.—incorporates a photoelectric cell which reacts to lighting conditions, switching one or more street lights on and off automatically. The unit features standard twist-lock mounting, time delay and voltage surge protection, directional sensing, low-power consumption and fail-safe operation. Since it has no tubes, the Controlite requires little maintenance. It is rated 1,000 watts at 120/240 volts. A Pioneer Electric representative points out the photo-electric cell.

2. Carter Battery Blanket—by James B. Carter of Winnipeg—is a new product designed to give auto batteries full strength for cold-weather driving. The blanket has a 40k/115v element woven with fibreglas insulation with a cover of heavy oil and acid-resistant plastic. A fibre stiffener is built into the unit to retain the blanket's shape. It can be used on all types and sizes of batteries, is quickly and easily installed. When temperatures skid to zero and below zero even fully charged batteries can provide no more than 50% of their normal energy. A plugged-in battery blanket assures easy cold-weather starting, protects the life of the battery and the ignition point system.

3. Snipe Runabout—by Kildonan Canoe Company of West Kildonan—a 13-ft fibreglas craft with sleek sports lines and chrome-tipped fins. It has scientifically designed chines, ample beam and transom widths, giving the Snipe stability and speed. Seats serve a double purpose—they also provide safety in the form of flotation tanks. The Snipe has a built-in bailer drain, fore and aft drainage, and a heavy rubber bumper guard to cushion the boat against damage when docking. It is available in four models and the top model—the super deluxe shown here—has upholstered seats, steering wheel and cable, windshield, bow and stern light, bow cleat, deck chock, stern cleat, transom handles and a bow eye. This medium-priced craft proved the top eye-catching exhibit at the fair. ★

Manitoba fair features new designs

"What's new in Manitoba" exhibit
displayed over 80 new products

Robert A. Metcalfe, Manitoba Editor





EXPANSION TYPES—for fast assembly in blind locations where there is access to one side only. Snap by hand into square holes.



FLAT TYPES—one piece, self-locking. Replace threaded nuts, lock washers and spanner washers.



COMPRESSION RINGS AND "C" CLIPS—for attaching plastic knob-to-shaft assemblies. Faster permanent assembly is assured.



PUSH-ONS—zip over unthreaded die-cast or plastic studs, rivets, nails, tubing or wire to lock parts securely.



"U" AND "S" CLIPS—for attaching metal, plastic or wood panels with a spring cushion. Eliminate holes in panels.



"J" TYPES—snap over edge of panels or into centre-hole locations. Hold themselves in place for blind assembly.



TUNING FASTENERS—for better, faster mounting of radio coil forms. Hold core in position and provide tension on adjustment screw.



"U" TYPES—perform same function as "J" types, used where full bearing on lower leg of the Speed Nut is required.



DART-TYPE CLIPS—dart portion compresses as it is snapped into hole; springs back to retain itself in place, or to lock panels together.



TUBULAR CLIPS—for use with unthreaded studs or rivets on attachments where there is access to front side only.



CABLE CLIPS—snap in place by hand and hold themselves in position by "heel and toe." Easily removed for servicing.



SPEED GRIPS—snap easily into bolt-receiving position without use of special equipment or skills; provide floating alignment.

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Ideas round-up

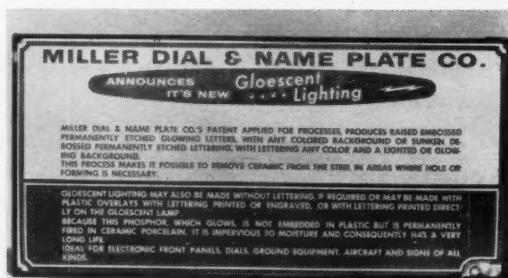
Electroluminescent lighting

This new concept of lighting has now been made practical for production of parts. It has been known that when a special phosphor treated dielectric is placed between two sides of an a-c current that the phosphor would glow. As the manufacturing tolerances are so highly critical, this material has been limited to a few handmade parts.

Now a procedure has been developed and patents applied for on the production fabrication of electroluminescent lamps. Several years of engineering development has resulted in reliable methods of converting electroluminescent panels into finished lamps. These lamps are made by applying various layers of insulating, conductive and phosphor bearing ceramic material to a .032 steel plate. Current consumption is only .1 milli-amp per square inch which produces a brightness of approximately .1 to .3 Footlamberts on 60 cycle and .4 to 1.0 on 400 cycle. The lamp is said to last 50,000 hours or over 12 years of use without appreciable dimming.

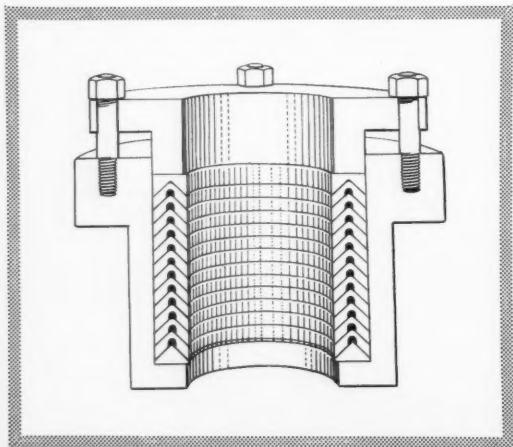
Typical applications include lighted control panels for heaters, radio and TV sets, missile ground equipment, advertising and informational signs, clock faces and instrument panels. *Source—Miller Dial & Nameplate Company.*

308



Fire resistant hydraulic fluids

Fire resistant phosphate ester-based hydraulic fluids have been in extensive use for several years, and their advent has substantially reduced the hazards inherent in the application of old style inflammable hydraulic mediums. However, these synthetics have posed numerous problems because these new fluids are not always compatible with existing packing compounds.



This point was recently made apparent at one of the aluminum processing plants. Here, a 250-ton hydraulically operated wheel type press, operating at pressures from 500 to 1,500 psi, is presently being used to straighten heat-distorted rectangular steel smelter pot shells. This horizontal, 18-inch stroke press has a 13-inch ram which was packed with a special duck and rubber compound "V" type packing when fire resistant fluid was first used as a hydraulic medium. Serious leaks developed around the stuffing box which could be stopped on the outward stroke by tightening the packing gland; however, this necessary tightening caused excessive binding of the packing on the ram which made the counterweight type pull-back ineffective.

In an effort to solve the problems connected with packing and pull-back, maintenance engineers ordered a set of duck reinforced butyl packings. The application of a relatively flexible package set, consisting of top and bottom adapters separated by C rings, brought the leakage under full control and permitted the use of the counterweight type pull-back by the addition of a simple air cylinder.

The use of this packing eliminated a fire hazard through the use of fire-resistant fluid which would not have been economical if the use of conventional type packing had been continued. *Source—Garlock Packing Company.*

309

Another Success Story in

Spring Design

from the Case History Files of

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This case history proves that specialized experience and creative engineering pay big dividends in the design and manufacture of springs, small stampings, wire forms and assemblies.

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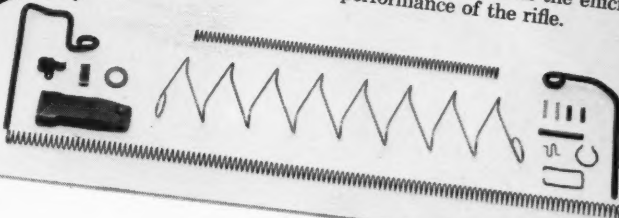
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PROBLEM Before going into production on the F.N. Rifle, Canadian Arsenals were required to make recommendations for improvement and North American production. Springs played a most important part in the 700 rounds-per-minute firing action, and many of them had to be redesigned to perform efficiently in extreme heat areas within the rifle.

20 PRECISION SPRINGS FOR THE FN INFANTRY RIFLE

SOLUTION Wallace Barnes was consulted on the practicability of spring design and manufacture. Several design refinements and the use of heat-resistant spring metals for high heat areas were recommended by Wallace Barnes' engineering team. The results of this specialized spring engineering have been proved in the efficient performance of the rifle.



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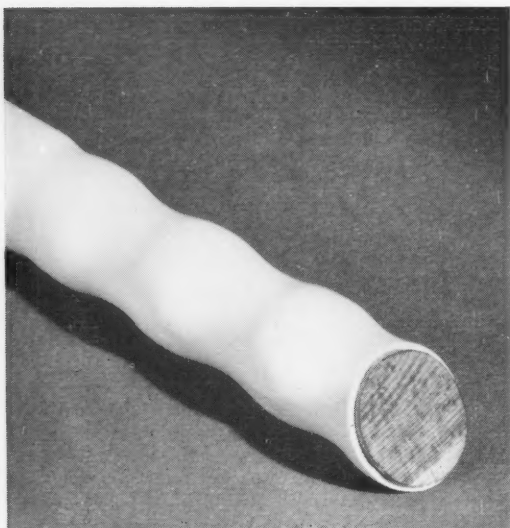
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Whenever it is desired to activate the material, it is immersed in a readily available inexpensive solvent for as little as 15 minutes—no damage is caused even if left in the solution for an hour—and simply applied over the metal, wood or other material which it is designed to cover. Shrinking will take place as it dries and the assembly can be handled within 20 to 30 minutes after the shrink-fitted plastic part has been applied. The plastic part will be completely dry after 24 hours.

The sculptured handle section, shown in the separate photograph, has a wooden centre covered with a heavy-walled shrink-fit tubing. This illustrates the fact that this process is not limited to only thin-walled extrusions. Almost any wall thickness can be specified. *Source—Anchor Plastics Company.*

310

Lightning arrester has expanding spring

In developing a new lightning arrester for use with the latest probe type aircraft antennas, the manufacturer incorporated into the design an unusual "expanding spring" method of fastening the unit to the antenna.

The new arrester utilizes 15 phosphor bronze spring elements to provide a slide-in, press-fit assembly with the plane's tubular aluminum radio antenna. The arrester's unique fastener design permits a fast, positive electrical connection to the antenna.

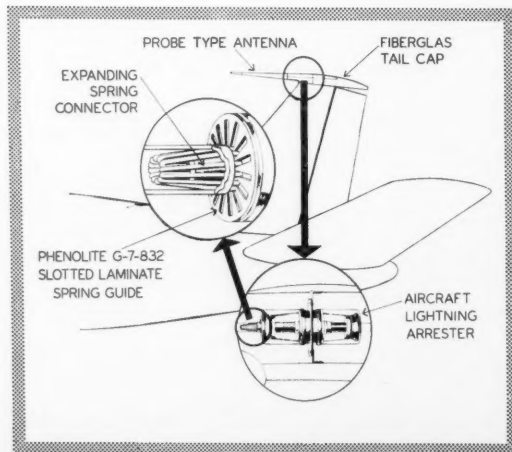
Key to the success of this design was the selection of the proper material to serve as a spring guide. This involved both electrical and mechanical considerations since the part must act as an insulator as well as a guide.

Arrester eliminates lightning hazards by guiding the lightning current from struck antennas through a preferred path to the structure of the aircraft, thereby preventing it from entering and damaging interior circuits. To do this, it employs protective gaps in a hermetically sealed chamber equipped with a ceramic capacitor. The capacitor permits the flow of radio energy between the antenna and the transmitter while at the same time acting as a barrier to lightning discharges.

Designed to operate at altitudes up to 50,000 feet and at temperatures ranging from -80 deg F to $+160$

deg F this aircraft lightning arrester will safely discharge lightning strokes having peak current as high as 100,000 amperes and 200 coulombs charge. The device weighs 7 pounds, 3 ounces. *Source—National Fibre Co. of Canada Ltd.*

311



THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS



FROM CORNING

HOW TO GET MORE USEFUL HEAT PER KW



It's not much to look at, but our new Vycor Brand Radiant Heater is loaded with advantages for those involved with drying, baking, curing or pre-heating.

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Long wave output is just one reason why your kilowatts will yield more useful heat. This heater also has a reflector system that includes a platinum strip bonded to one side of the tubing, and two layers of aluminized steel with Fiberglass insulation in the housing.

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With Vycor Brand Radiant Heaters mounted horizontally above or below your process line, you average 20 watts per square inch of working space and get full heating (800-850°F) in three minutes, so there's no costly warm-up delay. These units cool quickly, too, so you don't need complex equipment for diverting heat after shutting off the line.

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More facts? Use the coupon.

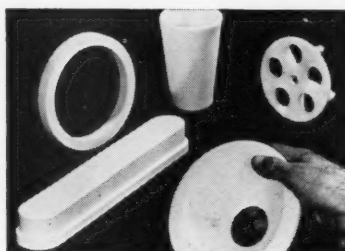
NEW MATERIAL FOR MISSILE MAKERS AND OTHERS WITH HIGH-TEMPERATURE PROBLEMS

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For example, you can now have cylinders, domes, crucibles, rods and slabs—in sizes equal to any achieved by conventional ceramic forming processes.



Corning's new Multiform Fused Silica offers the unique thermal and electrical properties of fused silica in shapes and sizes that up to now were considered impractical.

Softening point for this new material is 2880°F; you can design for *long-term* use at temperatures over 1770°F, intermittent up to 2250°F.

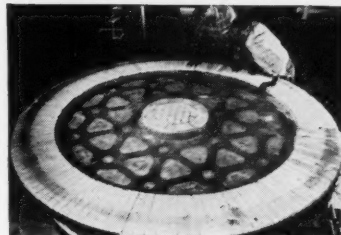
Resistance to thermal shock is high, since coefficient of expansion is 3×10^{-7} per degree F.

This new material also displays an extremely stable dielectric constant and a low loss tangent over a broad temperature range. Example: At a frequency of 8.6 x 10⁹ cps, the dielectric constant is 3.58 at 77°F and 3.57 at 750°F.

Through either slip-casting or dry pressing you end up with an object (a radome, perhaps?) that has an opaque, fine-grained structure machinable to tolerances of plus or minus .001 inch.

For samples of and/or detailed specs on new Multiform Fused Silica, mark the coupon and send it to our New Products Division.

A MIRROR FOR THE STARS



This is a glass telescope mirror blank that measures 84 inches across and weighs 4,000 lbs.

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Seven months the disk was annealed. Now at the Kitt Peak Observatory in Arizona, grinding and polishing will go on for an estimated 24 months. Final polishing will be done after the telescope is fixed on a star. Time for that? Another year.

Leading us to these facts: Patience is part of the art of the astronomer. And Corning can do almost anything with glass—be it a "one-shot," hand-tailored piece or mass production of small items at a very rapid pace.

Find out for yourself. The basic references are "This is Glass" and Bulletin IZ-1, "Designing with Glass for Industrial, Commercial and Consumer Applications."

Or outline your need in whatever detail seems feasible. Could be your star is just around the corner, with glass by Corning.



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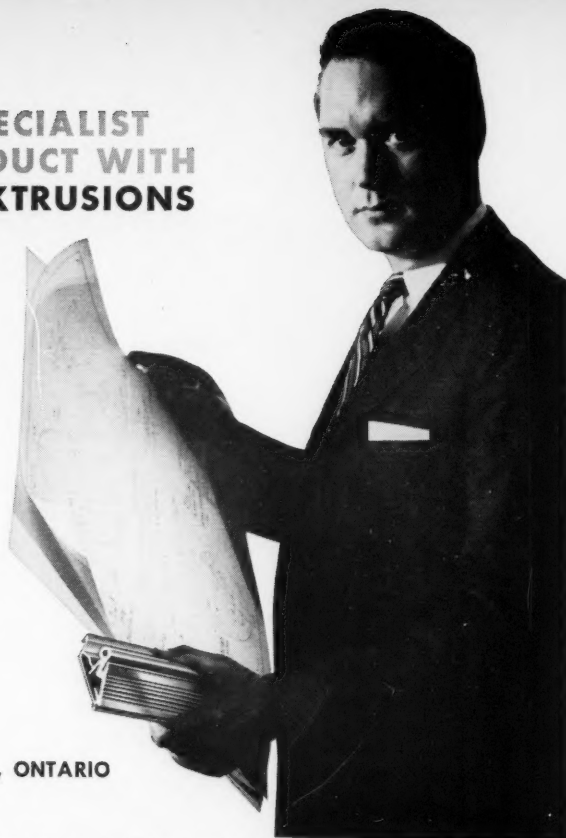
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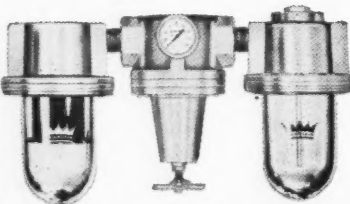
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Briefs

We note with interest . . .

Electrical power developed from fuel cells has been used for the first time in history (we are told) to power a vehicle. Un.t was a tractor developing 3,000 lb. of drawbar pull . . . **an all-glass**, wedge-base lamp has been marketed: it's about the size of a jelly bean — can be used in autos, radio and tv sets, control panels . . . **"Telex"**, an automatic teleprinter subscriber service, puts the rest of the world just seconds away (example: Sarnia to Vancouver less than 10 seconds) . . . **the construction** of Toronto's second subway may be an almost silent event if an Italian method finds favor. Bentonite, a heavy mud is the chief ingredient. There's been plenty of mud-slinging done at TTC meetings; it'll be a welcome change to have it done underground . . . **plans are being made** to produce continuous filament glass in Canada we hear, more than likely in Fort Saskatchewan, Alta. . . . **an electronic watchdog** has been developed which can do just about everything to keep out unwelcome visitors to plants and offices. It doesn't require a licence or taken for a late night stroll either — two important considerations in our book . . . **keeping the focus** on Fido, a new aluminum/polyethylene door for pets has been made. Dogs (and cats) can get in and out at will without letting in the weather, insects, drafts . . . **have a yen** to become a welder of aluminum but live in the country? You can now learn to weld this metal by mail says the Canadian Welding Bureau . . . **machines continue** to take over. A digital computer allows executives to match their management skills against each other, watched over by "E101". It evaluates their decisions and produces the verdict, we suspect, with a patronizing sneer flickering on its control board . . . **the Canadian Patent Office** has issued patent rights for an "outside window washer" to three Camrose, Alta., men. It takes all the risk out of washing windows in upper stories . . . **W. A. Robinson**, a design engineer for a U. S. company, said recently that completely automatic train operation is possible and practical today (better buy an engineer's striped workcap now while they're still being made) **if you think** you're a fast worker, what about the letter-sorter which is capable of sorting 43,000 letters an hour to 279 destinations . . . **with due salaams**, we were a bit flabbergasted when we discovered that DORCA wasn't a new, secret ingredient in Bloggs' toothpaste to

(Continued on page 64)

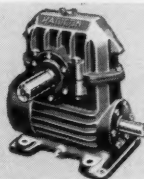
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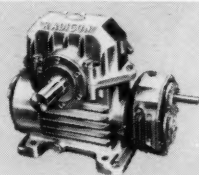
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Single reduction models. 60/1 ratio and 100 HP capacity. Horizontal and vertical models available from stock.



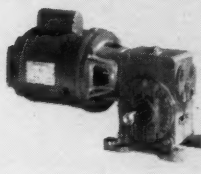
RADICON HELICAL WORM REDUCERS

Double reduction models up to 250/1 ratio. Horizontal and vertical models available.



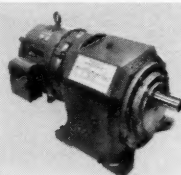
LITTLE RADICON GEAR MOTORS

Up to 2 HP capacity. Ratio 60/1 with NEMA standard flanged motors. Can be mounted in 8 different positions.



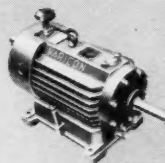
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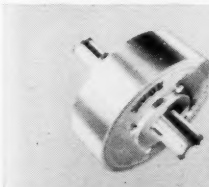
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Briefs Continued from page 63

relieve athlete's foot, but a new trade association. It means Door Opener and Remote Control Association . . . **one firm of designers** says that archaeologists, centuries hence, will think today's North Americans were so enamoured of their automobiles everything else had to have that car look, (the fins on vacuum cleaners, fruit juicers et al) . . . **a study** of the salaries received by 1959 graduates of Cornell University's College of Engineering shows the average starting pay to be \$530 a month (the high was \$640) . . . **there's nothing new** under the sun? Don't you believe it. Ever hear of worm scissors for anglers who don't like pulling worms apart; cigarettes made of sugar-coated charcoal for people who are afraid of smoking tobacco; collapsible rowboat; nylon envelopes that zip shut . . . **a noise annoys** more than an oyster, according to R. H. Tanner of Belleville, Ont. He's an acoustical consultant and says that few firms think about acoustical problems at the right time — when a new building is being designed — not when it's finished . . . **no need to burn** the old schoolhouse down. M.I.T. have designed an all-plastic school which can be expanded, converted, added-to at will.

(a couple of sharp boys and a spanner could work wonders after supper) . . . **a U. K. firm** has devised a portable one-man irrigation system featuring quick-acting connectors . . . **a machine** that can imitate any musical instrument, improve on it and then produce its own sound has been invented. If each variation was listened to for one second, it would take 140,000 years to hear all the combinations of music possible . . . **a recent piece** of direct-mail set us thinking hard. "Run your car half on gas, half on air," said the folder. We remembered a similar claim in another teaser which urged us to run our car half on gas, half on water. We're now looking into the possibility of combining both ideas and turning in our gasoline credit card . . . **large scale helicopter** production may begin in Canada within the next two years, we hear . . . **an internal combustion** engine with only two moving parts has been developed. Lightweight, it has a 100 to 700 hp range, needs no valves, springs, camshafts, pistons or connecting rods . . . **and a South-African** artist-sculptor living in London, England has invented an ornithopter — the world's first man-powered aircraft . . . **the physician** of the future won't need a photographic mind; he'll be able to dial a special code on the phone which will connect him to an electronic talking machine. This will dispense information about diseases, drug

actions (wish we could dial CC right now and get the cure for Common Cold) . . . **Atomic Energy** of Canada Ltd. has signed a technical agreement with Euratom (the European Atomic Energy Community) for the exchange of research information . . . **origination** of a new technique allows the prolonged storage of whole blood: the answer is in quick freezing to -320 F. This important step forward is sure to evoke the comment of how some types won't need the deep-freeze . . . **Canadian scientists** have developed a radio transmitter that will work after being slammed into the moon . . . **found — a method** of detecting Uranium-235 in quantities of one thousandth of one part per million parts in hafnium, zirconium, aluminum, stainless steel and other metals used to clad nuclear fuel elements . . . **Brief Talepiece:** extracts from a contract drawn up in 1878 by a group of engineers: "Each employee shall bring his own bucket of water and coal for the day. All employees are expected to be in bed by 10 p.m. Working time shall be 7 a.m. to 8 p.m. except the Sabbath, when everyone is expected to be in the Lord's House. Any employee who is shaven in public parlors, frequents pool rooms or uses tobacco shall be brought before management to give reasons why he should be continued in employment." Still pine for the good old days? ★

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Keeping informed

New booklets and technical data for you to read

Electron microscope — 12-page pamphlet gives technical data. From Industrial Research Foundation, Toronto.

Process Compressor — Clark Bros. bulletin No. 160 — an outstandingly prepared 44-page booklet on the subject.

Selenium Rectifiers — Plenty of information on rectifiers for industrial electric truck and locomotive battery charging. Powertronic Equipment Ltd.

Miniature Tubing — Canadian Research Institute has a 12-page catalogue on this subject and insulation test sets pH meters.

Military Components — This is a catalogue of military electronic components in which the Ohmite Mfg. Co. have participated. 32 profusely illustrated pages.

Stainless steel — stocks, finishes and services are discussed in Alloy Metal Sales 24-page handbook.

Balls unlimited — bulletin BU-1 tells about raw ball materials, methods of manufacture, size and quantities. Industrial Tectonics.

Tape-wound cores — precision-made cores, their precise limits and materials: bulletin TB-105 by G-L Electronics.

High strength steel — 24 pages of technical information: graphs, charts. Put out by Allegheny Ludlum Steel.

Fastening devices — pocket-size catalogue on Rawlplugs and accessory tools. Woodward Greiner Co.

Alloy performance — two technical bulletins covering data on vacuum induction melted superalloys. Kelsey-Hayes Co.

Automation — the use of air, water and oil cylinders and valve-cylinder combinations. Airmatic Valve folder from Pneumatic Industrial Eqpt. Co.

Free piston engine — If you're not sure what it is all about — an interesting 16-page booklet by Peacock Bros. will help you.

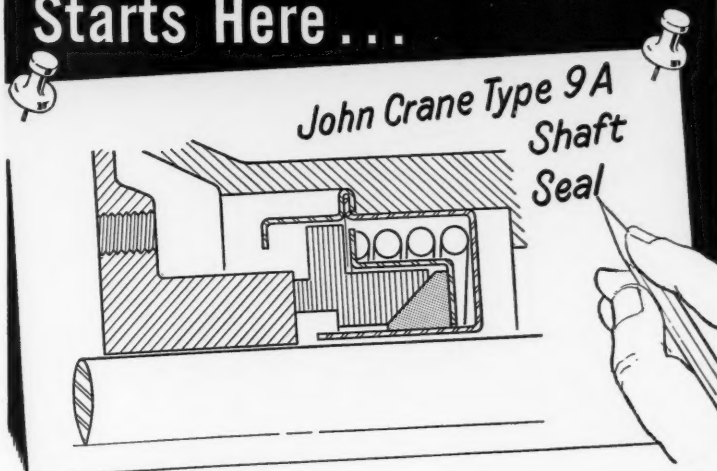
Sling chain safety — vital links to safety in the use, care and inspection of sling chains. Six-part kit by The McKay Co.

Electric raceways — how to protect them from corrosive atmospheres. Bulletin 18-177 published by CGE.

Controlled air power — Bulletin ML-5 or a panorama of production ideas on how to increase production per man hour. Bellows Co.

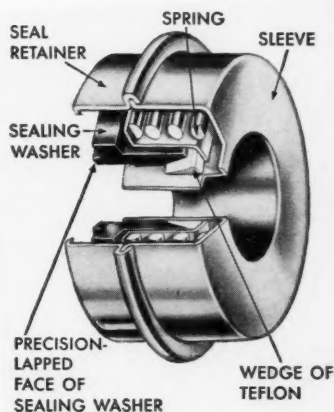
Phenolics — the facts on phenolics including diallyl phthalates. Hooker Chemical Company Inc. ★

Sealing Corrosive Liquids Starts Here...



This cartridge-type shaft seal designed for the production line is engineered for:

- (1) positive sealing of many industrial chemicals and solvents (note the Teflon* sealing wedge);
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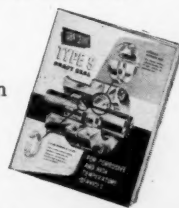
It offers the Original Equipment Manufacturers these important advantages:

- (1) low unit cost through mass production;
- (2) fast, one-piece installation through cartridge construction;
- (3) equal efficiency on both low or high speed applications, because seal does not rotate with shaft.

The 9A Shaft Seal can be of stainless steel, monel, brass or other materials adapted to stamping and forming—depending on the service requirement.

Get full details. Request Bulletin S-205-3 from

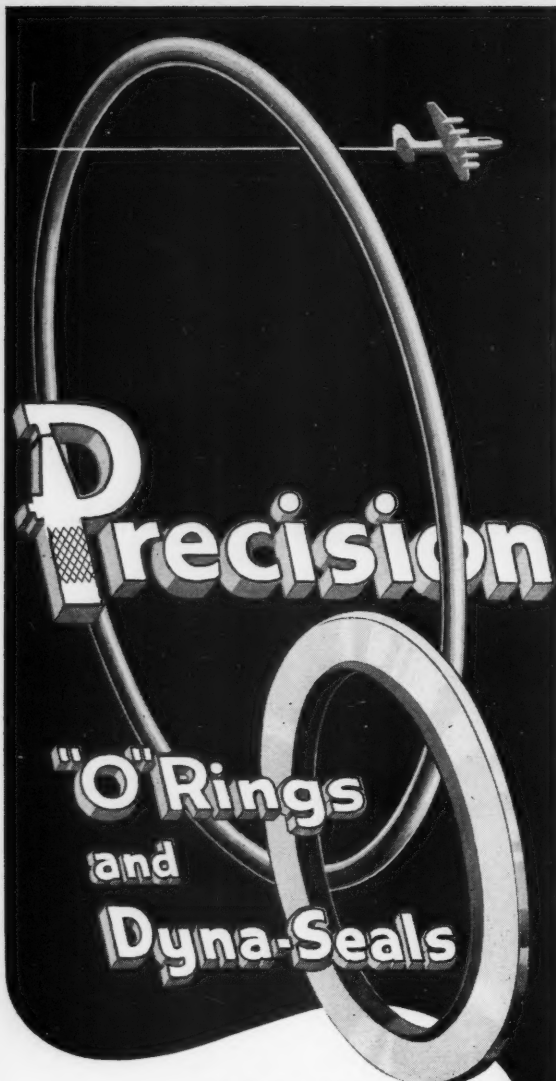
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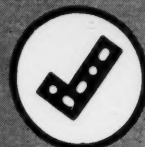
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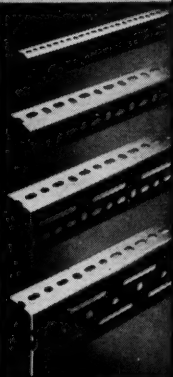
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People in the news

Recently appointed as manager of Canadian Westinghouse Co.'s atomic energy division—**Lawrence C. Sentance**. He is mechanical engineering graduate of U. of Saskatchewan.

★ ★ ★



Sentance



Grimley

Dr. S. Slater Grimley has been appointed research manager of Canadian Industries Ltd. Dr. Slater is a graduate of the Imperial College of Science and Technology of the University of London.

★ ★ ★

A U. of B. C. chemistry graduate, **J. S. Bagnall** has been promoted to product sales manager, adhesives and resins division of Monsanto Canada Ltd. **D. J. Druhan** has been appointed patent administrator of the same company.

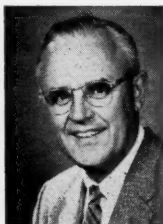
★ ★ ★

Formerly application engineer in the Toronto office of Vickers-Sperry of Canada, **Bruce C. French** has been appointed district sales manager of the Toronto office.

★ ★ ★



Von Kaufman



Leahey

Named as president of Hayes Steel Products, Merriton, Ont., is **Von R. Kaufman**. He is an active member of the S.A.E., C.M.A. and Canadian Chamber of Commerce.

★ ★ ★

McGill graduate **J. C. Leahey** has been appointed district manager of the industrial division of Timken Roller Bearing Co. Montreal.

★ ★ ★

A. G. McNichol becomes manager of

industrial engineering for Canada Iron Foundries Ltd.

★ ★ ★

Now responsible for services, production, industrial relations—**E. W. Ryan** in his new appointment as superintendent of latex and reclaim division, Dominion Rubber Co.

★ ★ ★

Now chief sales metallurgist of Noranda Copper and Brass Ltd.—**M. A. Vachon**. He has been with the company since it was founded in 1947.

★ ★ ★

Peter Marani has been named supervisor

of mobile training of the GM Diesel mobile training unit.

★ ★ ★

New president of Servomechanisms (Canada) Ltd. is **Donald C. Stewart**. **Irving M. Liss** is director of engineering and sales; **George Kusunoki**, manufacturing manager and **John H. Pile**, chief of technical sales.

★ ★ ★

An engineering graduate of U of Toronto **E. W. Ankenman** has been appointed sales engineer for "Microsen" electronic controls.

(Continued on page 71)



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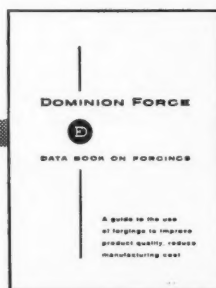
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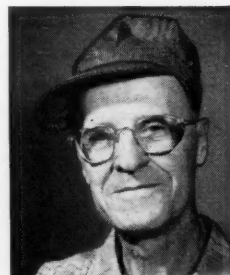
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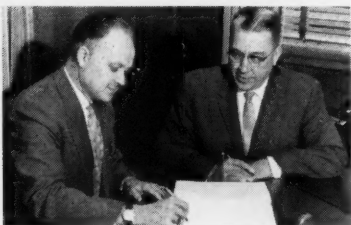
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People in the News (continued)



Canmark Services Ltd. was recently appointed national distributor for electric motors and motor controls for Canadian Allis-Chalmers. Photo shows **H. M. Schudt** (right) president of Canadian Allis-Chalmers signing agreement with Canmark president **Clifford Ainsworth**.

★ ★ ★

David Hickling has been appointed assistant to the manager of Graver Water Conditioning Co. Hickling is a Cambridge University graduate in physics, chemistry and metallurgy.

★ ★ ★

Now field sales manager for The Cosa Corporation of Canada is **T. P. (Ted) Shutze**. Previously in charge of the company's Deckel Division, Shutze has 20 years experience in the machine tools field.

★ ★ ★

C. M. Basile has been elected president of Link-Belt Speeder Corporation. Less than a year ago he was appointed president of Link-Belt Speeder (Canada), Woodstock, Ont. ★

Letters to the Editor

Role of consultants

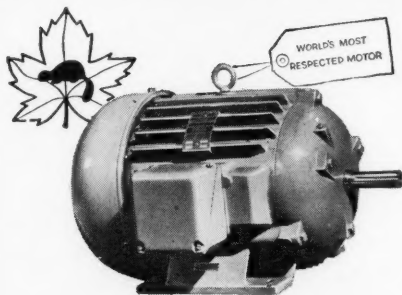
Dear sir:

An article that appealed to me was in the field of administration "Role of consulting engineers in design." This is a field in which very little information is available regarding problems of administration unique to Canadian industry. Many American magazines carry articles on the subject but too often they are not applicable to problems in Canadian industry. I look forward to seeing more articles in this field in the future.

G. B. Bergquist,
Canadian Westinghouse, Hamilton

*Articles on engineering administration have always appealed to your editor. We will do our best to carry them regularly.

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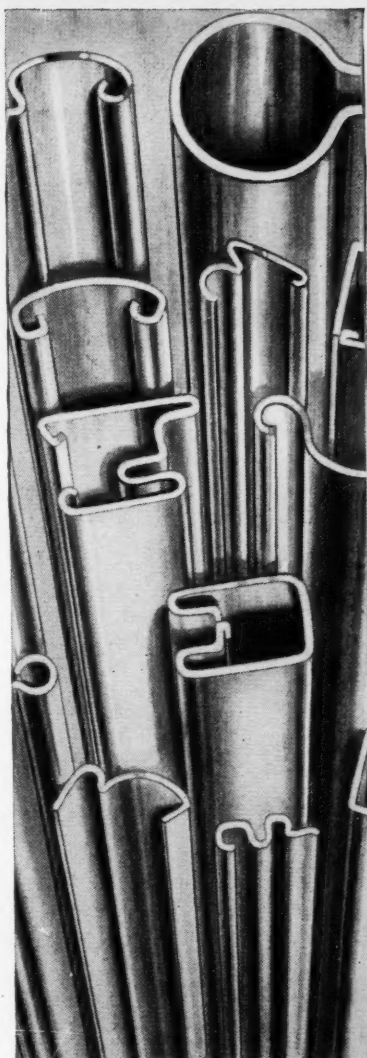
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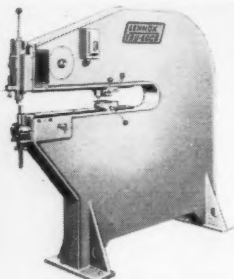
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New products & materials

Shearing, forming and piercing

This new model, has a maximum edge-cutting capacity of 9/32 in. in mild steel plate and 3/16 in. stainless steel. Throat depth is 49 1/4 in., permitting circle cutting up to 48 in. dia. inside the throat.

Like its predecessors, it operates with a reciprocating upper and stationary low-



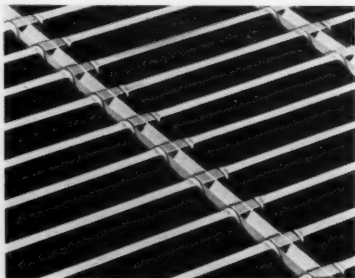
er tool. An infinite range of tool strokes is available from .035 in. length through .250 in., with strokes per minute (in relation to material thickness) being automatically regulated when setting stroke length. Model TE-281 has a cutting speed of up to 36 fpm. with number of cuts per minute from 1750 to 3500. **Lennox Tool & Machine Builders.** 312

Amino-functional silane

Called **Dow Corning Z-6020**, this new amino-silane chemical reacts with both organic and inorganic materials and has the ability to couple them together. This is of particular interest to manufacturers using pigments or dyes, cements or metallic oxides, since Z-6020 will aid water dispersion. The amino-silane appears to form a monomolecular film around inorganic particles which helps prevent agglomeration of the particles. 313

New welded grating

The one-piece "Gary" grating uses hexagonal cross bars for maximum design efficiency. Standard units are made with main bars on 1-3/16 in. centres and cross bars on 4 in. centres, in panels 36 in. wide and up to 36 ft. long.



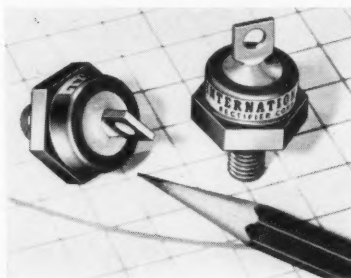
Special styles and spacing are also available for a wide range of industrial and commercial applications.

Standard Steel Construction Co., Division of United Steel Corporation Limited. 314

Low-cost silicon diode

A series of low-cost 25 to 35 amp, 50 to 500 PIV-rated silicon power rectifiers designed specifically to provide exceptional performance (including operation to 130C base temperature) in commercial equipment applications, has been marketed.

This series embodies a new technical advancement in the sealing of silicon rectifier junctions termed "Quad-Sealed" — a four-layer seal assuring high resistance to humidity, shock, vibration, temperature extremes and other adverse environ-



mental conditions.

Diodes in this series feature an oversized anode lug which efficiently removes heat from the rectifier junction... allows the unit to withstand unusually high peak current surges. **International Rectifier Corporation.** 315

Hydraulic ramps

A new series of universally adjustable loading and unloading ramps are now available in Canada. They are manufactured by **Canada Crane & Hoist Co.** of Toronto under license from **Beacon Machinery Inc.** of Illinois.

Most versatile model in the line has vertical, horizontal and lateral movement, operated by hydraulic cylinders and push-button controlled. When a truck comes to the loading dock, the ramp is first raised vertically, aligned laterally and then extended horizontally to overlap the tailboard of the truck. These facilities are said to eliminate time wasted in manoeuvring large vehicles in alignment with the dock. Even if the truck is at an angle to the dock, independently movable fingers compensate the difference. Once in position, the floating ramp deck automatically adjusts to changes in the

truck's attitude due to depression or expansion of the springs.

The Beacon ramps are self-contained assemblies with integral hydraulic motor-pump units. They may be located in a specially prepared pit or just fixed to the front of existing docks. 316

Digital clock

Telephone type relays and stepping



switches are used in the new **Datex DC-112 Digital Clock** to provide long life under continuous operation. The clock, is designed to provide a digital output in the form of contact closures representing hours, minutes and seconds. The output can be in decimal, binary or binary coded decimal form.

Individual "time set" push buttons are mounted directly below each digital display window to permit setting each digit independently. A "zero reset" button is also provided. **Datex Corporation.** 317

Tiny package controls

Miniaturized "package" controls, designed to do the work of larger units in all but the most sophisticated applications, are now available.

The new line comes in round or rectangular models and if desired may be ruggedized and sealed for such military applications as missile ground support equipment.

MIL-type components are used wherever applicable. **Assembly Products, Inc.** 318

Vibrator

For precision finishing, this vibrator operates from 10 to 100 times faster than tumbling barrels of comparable capacity. It will clean, descale, debur, radius, fine finish, color, burnish or ball burnish metal, wooden or plastic parts.

Media, compound and water are required as with conventional tumbling if a wet process is used. The load of parts and media rotates as a mass, and an additional scrubbing action between the load constituents is induced through the controlled vibration. Both the amplitude and the frequency of vibration can be controlled, allowing the vibrator to do everything from coarse work, requiring severe cut-down, to the most delicate precision jobs. Interior finishes and finishes in shielded areas can be obtained. **Lord Chemical Corp.** 319 ★



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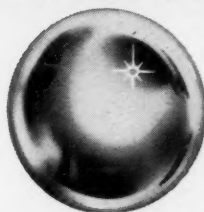
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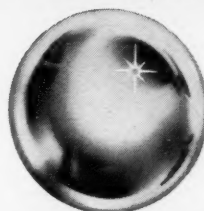
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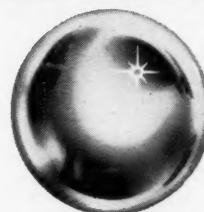
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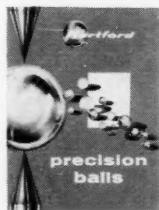
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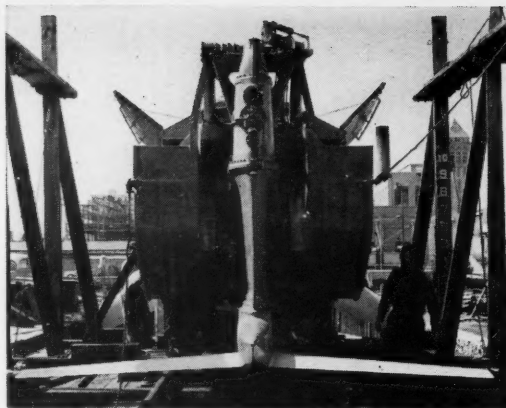


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1. Craft begins its hydrofoil flight. A five-fold increase in speed, absence of roll are the major results.



2. Tail end view shows the spread of the rear foil; the screw is a standard marine propeller. Note size of craft.

Flying duck takes-off with hydrofoils

The World War II DUKW gets a new lease on life by taking to the air

The U.S. Army, in quest of increased mobility, has unveiled its latest concept, the "Flying Duck"—a truck that floats like a boat and flies like an airplane.

Developed by Avco Corporation's Lycoming Division under a contract with the Army's Ordnance Corps, it is a gas turbine powered, hydrofoil version of the famed World War II DUKW, an amphibious landing craft that became so familiar to servicemen in both the Pacific and European theatres.

The craft uses its 860 horsepower Lycoming gas turbine engine, which normally powers helicopters and airplanes, in combination with aerodynamically shaped hydrofoil wings to attain water speeds up to 50 miles per hour. The World War II version had a maximum water speed of only six miles per hour.

On water, the vessel begins operations in much the same fashion as a conventional boat. However, when it reaches a speed of five miles per hour the water flowing around the hydrofoil wings which are extended below the surface acts in the same manner as does air flowing past an airplane wing. The pressure above the foil is reduced in relationship to the pressure below, giving lift. At 13 miles per hour this lift is sufficient to raise the vehicle well out of the water. At full flight condition the hull is more than four feet above the surface. The three hydrofoils, two forward and one at the rear, travel approximately 30 in. below the surface.

With the hull completely out of the water, more than sixty percent of the drag normally associated with boats is eliminated, thereby allowing for the tremendous increase in speed. The ability to maintain these high speeds over long rough water hauls is its greatest single advantage over conventional craft. In addition, several other important advantages are gained, one of these being the lack of any seasickness-causing motion. This is accomplished through the use of an automatic pilot which senses the waves ahead and then controls the

foils to compensate for any variations, even in relatively rough water. The two forward foils are hinged at the rear to allow for either automatic or manual control of the angle of the hydrofoils.

The hydrofoil principle is not a new one and experiments with them have been conducted as long as fifty years ago. Several models were built but all proved to be either expensive, unwieldy or otherwise impractical. Even today, several commercial models are in limited use in various parts of the world and hundreds more are used on very small racing boats. However, these are primarily of a highly simplified form that is impractical for military or wide scale commercial use.

Ultimate aim was twofold: first, to demonstrate that it is possible to operate wheeled amphibious vehicles on hydrofoils and to successfully marry this combination to a gas turbine engine; second, to develop a vehicle that can carry cargo and personnel over long rough water hauls at high speeds with a high degree of manoeuvrability. The flying type vehicle, in addition to a water speed of 50 miles per hour can operate for approximately five hours with a range of 250 miles. It can also operate on the high seas from a "mother" ship.

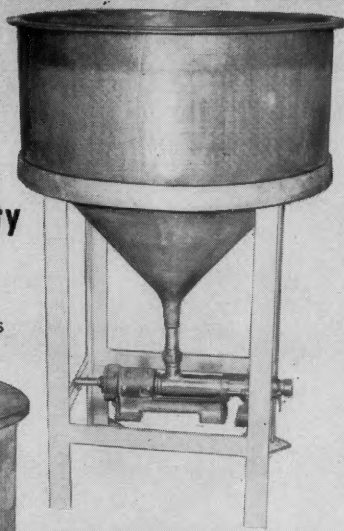
Among its valuable assets is the fact that the "Flying Duck" is among the few existing surface vessels capable of catching an atomic submarine. It can maintain level high speed flight in choppy sea conditions of four foot waves as well as negotiate rough ocean seas and surf.

These capabilities qualify it for such assignments as anti-submarine patrol, air-sea rescue duties, a mobile missile launching platform, and as a platform from which to launch frogmen operations. One of its more obvious uses is for amphibious invasions which would allow the transporting of cargo and troops from 100 miles out at sea to inland dumps in a matter of two hours rather than the fourteen hours previously needed.

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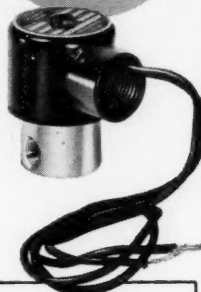
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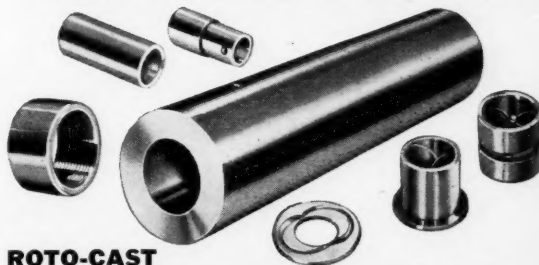
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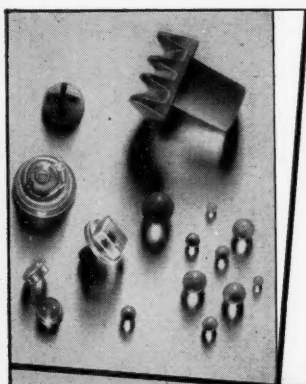
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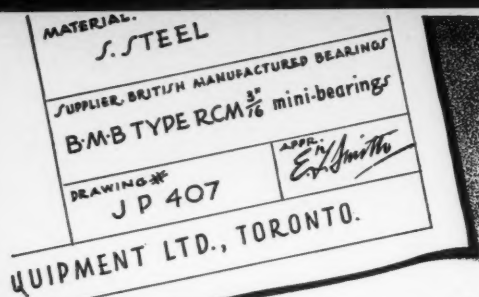
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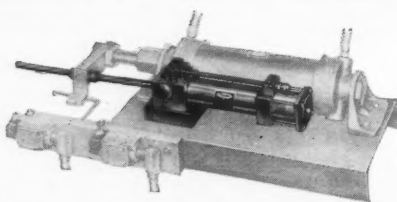
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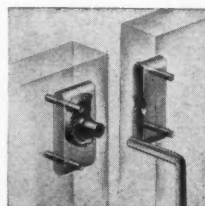
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Editorial

A look at the sixties

This edition of DESIGN ENGINEERING goes into the mails just as we are preparing to usher in a new year — 1960 — the beginning of a new decade.

We have been wondering what sort of a "tag" will be hung on this decade ten years from now. We have endured the threatening thirties, the fighting forties and are just seeing the last of the fabulous fifties.

And now come the sixties. Will they be known as the *space-age* sixties? the *suicidal* sixties? the *speculative* sixties? or maybe even the *spurious* sixties? It depends to a great extent on us — the design engineers of Canada.

Let's look at some of the targets we should be shooting for during these impending years:

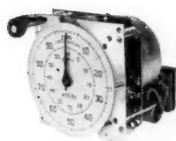
1. A sound decision on the right or wrong of Canada's atomic power development program — a decision based on facts and figures alone — with all this nonsense of personalities left on the sidelines.
2. A more active participation by Canadian engineers in the government of their municipalities and their country. (Look for a feature story on this in an early issue — the facts do **not** make good reading.)
3. A recognition by all concerned that Canadian engineers can, and do, come up with designs that are second to none.
4. A more realistic approach by some labor leaders in their demands on Canadian industry — we fear that if the present trend continues Canadian manufactured products will soon be priced right out of the world markets. The move by many U. S. firms to establish European subsidiaries foreshadows the struggle to be waged there.
5. An aggressive public relations program right across Canada on behalf of the professional engineer and his technician partners. At least one provincial association has scratched the surface on this matter, but the title "P.Eng." is still not well enough known — especially to those in high places.
6. More co-operation between the various technical societies and between the societies and the provincial engineering associations. There is too much overlapping of effort at the present time—too little attention being paid to the furthering of the technical know-how of the practising engineer—too many non-active society members.

These, then, are some of the targets on which we should set our sights. How close we come to a perfect score depends on each one of us, individually. May we suggest that every design engineer in Canada load up, take aim, and fire — on a continuing basis — until all the targets have been hit. Let's make them the satisfying sixties!

Doug Kaill



Miniature Might. Tiny Oyster Drills (*Urosalpinx Cinarea*) are noted destroyers of their much larger fellow-mollusks — oysters. One of 80,000 mollusk species, the Oyster Drill feeds on his victims through a shell-piercing snorkel.



Maximum Precision for the entire mechanism of this electric timer is assured by MPB bearings mounted on shaft ends and in gear trains. By reducing torque, these stainless steel bearings mean longer life and less maintenance for the timer.



Man with Miracles. Sales Manager Ken Broman heads MPB Sales Engineers in their engineering and consultative service to industry. One of these highly experienced MPB technical men is always ready to help solve your miniaturization problems.

More Miracles in Miniaturization



ACTUAL SIZE OF BEARINGS USED
IN ELECTRIC TIMER SHOWN ABOVE

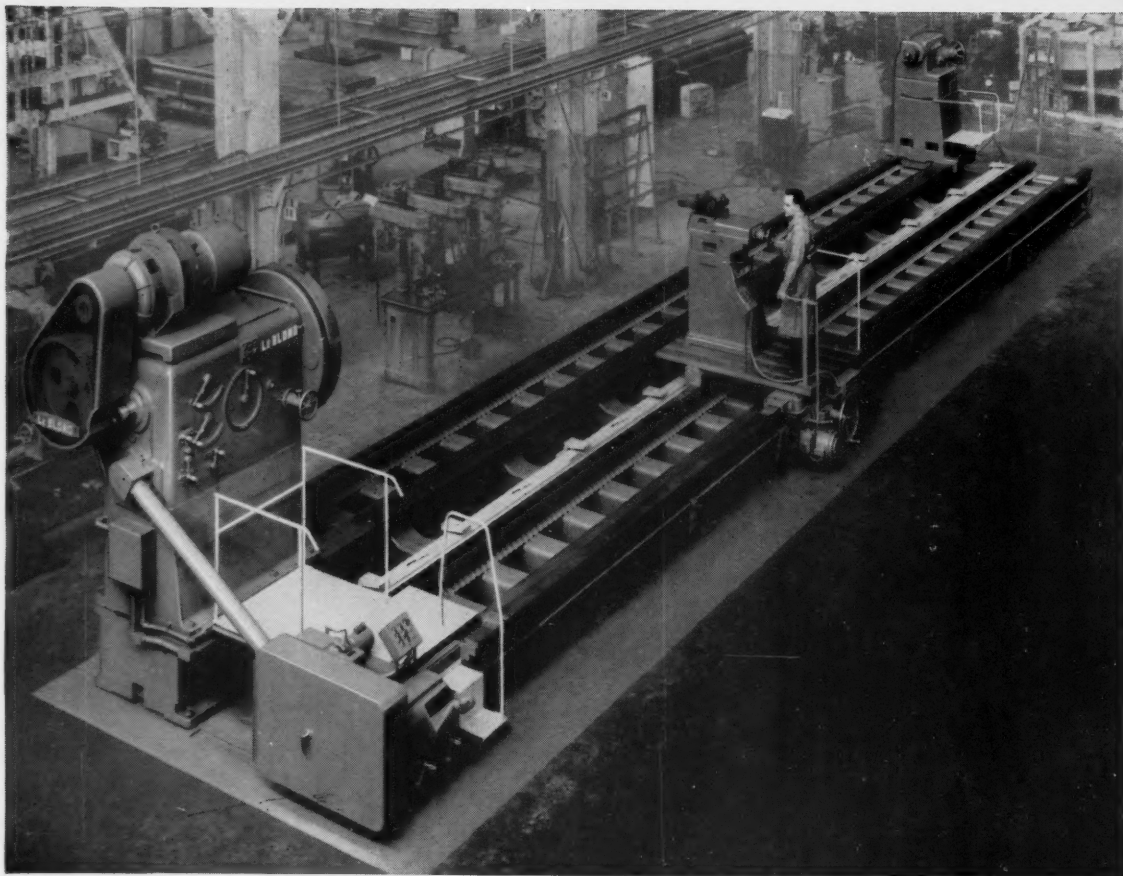
Designing and redesigning to meet modern requirements calls for miniaturization on a grand scale. Components for aircraft or outer space missiles must be reduced to minimum size and weight. Greater precision is needed in complicated, compact mechanisms and expert miniaturization is sought throughout industry. MPB helps you perform miracles in miniaturization by producing over 500 types

and sizes of bearings ranging from 3/8" O.D. down to 1/10" O.D., with specials as required. For an illustrated catalog containing complete facts on these bearings, for engineering advice or both, write MPB distributor: **Lyman Tube and Bearings, Ltd.**, 5420 Pare Street, Montreal. Additional offices: Toronto, London, Winnipeg, Vancouver and New Glasgow.

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First U.S. double-bed lathe... Le Blond's huge "Admiral"... assures spindle rigidity with Timken bearings

IT'S a giant!... this lathe built by R. K. Le Blond Machine Tool Co. Named the "Admiral", it's the first U.S.-built double-bed lathe. And it weighs 75 tons, is 54 ft. 6 in. long, 120 in. wide. To maintain spindle rigidity under 50,000 lb. line load, Le Blond mounts it on Timken tapered roller bearings. And for extra quality, the lathe ways are made of Timken 91140 steel. Le Blond uses Timken bearings to get:

- 1) *Special precision.* Timken bearings are made specifically for precision spindle applications.
- 2) *Extra load-carrying capacity.* Full-line contact between rollers and races gives Timken bearings extra capacity and their tapered design lets Timken bearings take *both* radial and thrust loads. They hold the spindle rigid.
- 3) *Extra toughness.* The bearing's heart—the steel—is the finest bearing steel available.
- 4) *Virtually eliminate friction.* Timken bearings are designed and precision-made to roll true.

For machines that perform better at

lower cost, be sure the ones you buy or build are equipped with Timken tapered roller bearings. **When you buy Timken bearings you get...**

- 1) *Quality you can take for granted.*
 - 2) *Service you can't get anywhere else.*
 - 3) *The best-known name in bearings.*
 - 4) *The pace setter in lower bearing costs.* The Timken Roller Bearing Company, Canton 6, Ohio, U.S.A.
- CANADIAN PLANT:** St. Thomas, Ont. Cable address: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*



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